Volume 22, Number 19, October 15, 1968

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Division of Technical Information, Edward J. Brunenkant, Director,
Published by the USAEC Divison of Technical Information Extension, Robert L. Shannon, Extension Manager.

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Index References

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
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Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
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    21:8905(R) (AD-631189)
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SHELTERS
  construction of, for civil defense,  21:8838
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  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y–1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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TID-
  3311(Suppl. 2)  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  22298           21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                              1966)
  22298           21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                              1967)
  23267           21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                              1966)
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  23420           21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474           21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 28, 1966.

Volume 22, Number 19 October 15, 1968

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 40063, 40685, and 40819.

39975 (AERE-R-5758) THE DETERMINATION OF HYDROGEN AND DEUTERIUM IN ZIRCONIUM ALLOYS USING AN MS 10 MASS SPECTROMETER. Cottell, K. R. J.; Quarmby, Marion; Shalgosky, H. I. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1968. 6p. Dep. CFSTI. UK 1s. 9d.

An MS10 mass spectrometer was connected to a hot vacuum extraction system and calibrated for measurements of hydrogen, deuterium, and hydrogen deuteride. Analysis of samples of Zircaloys showed that the coefficients of variation for single determinations of hydrogen and deuterium were ±1.2 and ±2.8%, respectively; the limits of detection were 0.03 and 0.0017 μg, respectively. (auth) (UK)

39976 (ANL-7450, pp 108-11) DETERMINATION OF BURNUP IN FAST REACTOR FUELS. (Argonne National Lab., Ill.).

Topics covered include: spectrophotometric titrations of total rare earths, x-ray spectrometric determination of rare earth fission products, evaluation of burnup monitors for oxide fuels, and irradiation in EBR-II. (M.C.G.)

39977 (BNL-50118) DETERMINATION OF OXYGEN IN SODIUM BY THE AMALGAMATION METHOD. Prach, T. F.; Newman, L.; Auerbach, C. (Brookhaven National Lab., Upton, N. Y.). June 1968. 22p. Dep. CFSTI.

The amalgamation method, when used with the proper precautions, was found to be capable of reliable and reproducible determination of oxygen to ±1 ppM, down to the 1 ppM level. Its main disadvantage, especially when radioactive samples are involved, is the large number of manipulations required. The method is being used routinely for analyzing loop samples as well as sodium from a number of special experiments. (auth)

39978 (CNEA-209) DETERMINACION PRECISA DE URANIO EN OXIDO URANOSO URANICO DE ALTA PUREZA. (Precise Determination of Uranium in Uranous–Uranic Oxide of High Purity). Zucal, R.; Casabe, J.; Bianco, G. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 12p. (In Spanish). Dep.

A method for the precise determination of uranium in uranous–uranic oxide was studied, based on the determination of the uranium(IV) present. Theoretical considerations permit the establishment of the ratio total uranium/oxide starting with the experimental data on uranium(IV), with a precision ten times that obtained in that determination. The determination is carried out by dissolving the oxide in a mixture of phosphoric acid (85% by volume) and concentrated sulfuric acid, then oxidizing with a weighed quantity, in excess, of potassium dichromate and determining the excess of the oxidizing agent colorimetrically. In comparing the results of the proposed method with those obtained with the other method based on the determination of total uranium, no significant differences were observed in the ratio uranium/oxide in the same oxide sample. The precision obtained is of the order of 0.01%. (tr-auth)

39979 (CNEA-224) DETERMINATION OF INORGANIC RADIOIODINE IN COMPOUNDS LABELED WITH ^{131}I BY THIN LAYER CHROMATOGRAPHY. Camin, L. L.; de Troparesvsky, Maria L. P.; de Salas, G. N. B.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 8p. (In Spanish). Dep.

The principal impurity in organic compounds labeled with radioactive iodine, used frequently in medical diagnosis, is inorganic radioactive iodide. A method, making use of thin-layer chromatography, is presented for the rapid determination of inorganic radioactive iodide in various molecules labeled with ^{131}I and the quantitative determination using a detector over a moving tape (Radioscanner, Packard Model 7200). (E.J.H.)

39980 (EUR-3624) ETUDE THEORIQUE ET EXPERIMENTALE DES FLUX DE NEUTRONS THERMIQUES DANS DES HYDROCARBURES ET APPLICATION DES RESULTATS A LA MESURE DE LEUR DENSITE ET A LA RECHERCHE DE LEUR COMPOSITION. (Theoretical and Experimental Study of Thermal Neutron Fluxes in Hydrocarbons and Application of the Results to the Measurement of Their Density and Composition). Corompt, P.; Molinari, J.; Calmels, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 1968. Contract 089-64-12 IRAF. 10∪p. (In French). Dep.

Plant control of the physico-chemical properties of a hydrocarbon generally necessitates samplings and laboratory analyses, which are incompatible with the development of automation and the optimization of the production units. The possibility is examined of using penetrating nuclear radiations for the continuous in-channel measurement of the density and chemical composition of hydrocarbons. The solution adopted is the linking of a gamma absorption measurement with a measurement of the thermalization of neutrons emitted by a sealed americium-241/beryllium source. The construction of an experimental apparatus was preceded by an experimental and theoretical study on neutron scattering in hydrocarbons. The results obtained from this preliminary study relate to the thermal-flux distribution in the vicinity of a neutron source. They can be generalized and extended to cover a number of hydrogenated media. The precision of the density and chemical composition (C/H ratio) measurements obtained with such a combination of gamma radiation and neutrons is limited by the statistical fluctuations of counting and above all by the nonlinearity of the phenomena observed. In the most favorable case, with the aid of calibration nomograms for the neutron probe, the precision of the measurements obtained did not exceed 0.2%. (auth)

39981 (EUR-3934) THE DETERMINATION OF FREE ACIDITY IN PLUTONIUM CONTAINING SOLUTIONS AND THE SEMI-QUANTITATIVE ACIDIMETRIC ESTIMATION OF PLUTONIUM. Buijs, K.; Chavane de Dalmassy, B.; Maurice, M. J. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). 1968. 10p. Dep.

A fast method for the determination of free acid in plutonium solutions was developed. An ammonium fluoride solution provides the medium in which hydrolysis of plutonium is prevented. (auth)

39982 (JEN-188-DQ/1-64) DESCRIPCION DE UN EQUIPO, CON RECINTOS BLINDADOS, PARA EL ANALISIS ESPECTROGRAFICO DE SOLUCIONES DE RADIOISOTOPOS. (Description of Equipment With Shielded Cells for the Spectrographic Analysis of Radioisotope Solutions). Roca, M.; Capdevila, C.; de la Cruz, F. (Junta de Energia Nuclear, Madrid (Spain)). 1967. 16p. (In Spanish). Dep.

Two lead-shielded cells for spectrochemical analysis of radioisotope samples are described. One of them is devoted to the evaporation of samples before excitation and the other one contains a suitable spectrographic excitation stand for the copper spark technique. A special device makes possible the easy dis-

placement of the excitation cell on wheels and rails for its accurate and reproducible position as well as its replacement by a glove box for plutonium analysis. In order to guarantee safety the room in which the spectrograph and the source are set up is separated from the active laboratory by a wall with a suitable window. (auth)

39983 (KR-126, pp 143-52) REPROCESSING ANALYSIS: GENERAL CONSIDERATIONS. Hardwick, W. H. (Atomic Energy Research Establishment, Harwell, Eng.).

A very general discussion of the role of analytical chemistry in reprocessing is presented. The value of and errors influencing a mass balance across the plant are discussed with the 3 main sources of error being errors in calculating fissile content of fuel burnup, errors in measuring volume and concentration of the solution from the dissolver, and plant loss. The importance of in-line analytical instrumentation in plant control is mentioned briefly. A tabulation of analytical methods for nuclear materials control in a fuel processing plant is included. (B.L.M.)

39984 (KR-126, pp 153-71) REPROCESSING ANALYSIS: SELECTED PROBLEMS AND METHODS. Bonnevie-Svendsen, M. (Institutt for Atomenergi, Kjeller, Norway).

Characteristic problems and methods associated with the determination of fissile materials (U and Pu), fission products (mainly the extractables, i.e., Zr, Nb, Ru, and Ce), free acid, and solvent purity are reviewed. The present state of analytical techniques and instrumentation makes most problems in reprocessing analysis a choice between a variety of satisfactory methods. The question of cost, both in time and money, often dictates the choice. The requirements of an analysis should be based on a realistic estimate of what is really needed and should even consider the influence of other variables, such as representativity of the samples and measurement of flows and volume in the plant. In some cases automation and in-line instrumentation can increase the reliability of an analysis and decrease the cost. However, for high-precision accountancy analyses and for control of research and pilot-plant work, manual procedures are found to be mostly superior. (B.L.M.)

39985 (MLM-1486) DETERMINATION OF PARTS-PER-MILLION QUANTITIES OF ^{236}Pu IN ^{238}Pu. Smith, W. H.; Tomlinson, F. K.; Eppink, D. W.; Hagee, G. R. (Mound Lab., Miamisburg, Ohio). Sept. 18, 1967. Contract AT(33-1)-Gen-53. 23p. Dep. CFSTI.

Two methods for the determination of ppM quantities of ^{236}Pu in ^{238}Pu plutonium dioxide are compared. One method involves the direct measurement of the ^{236}Pu while the other method involves an indirect measure of the ^{236}Pu content of the material. The direct method consists of alpha pulse height analysis of a $^{238}PuO_2$ sample deposited on a thin metal slide. The indirect method consists of the radiochemical determination of the ratio of the concentration of the daughter products of ^{236}Pu and ^{238}Pu (i.e., ^{232}U and ^{234}U. (auth)

39986 (ORO-3561-1) PROGRAM TO EXPLORE AND EVALUATE POTENTIAL APPLICATIONS OF RADIOISOTOPE EXCITED X-RAY FLUORESCENCE TECHNIQUES IN CRIMINALISTICS AND NATIONAL SECURITY. Annual Report. Sellers, Bach,; Wilson, Henry H.; Ziegler, Charles A. (Panametrics, Inc., Waltham, Mass.). Sept. 29, 1967. Contract AT(40-1)-3561. 18p. Dep. CFSTI.

Advances in methods of generating and detecting x-rays, coupled with improvements in miniaturization of electronics, motivated an investigation on the possibility of using this technology in the areas of criminalistics and national security. Specifically, the advent of radioisotope sources for x-ray generation permit the construction of simple-to-use, compact, portable systems suitable for use in the field by law enforcement personnel. In order to ascertain potential applications a survey involving fourteen government and nongovernment law enforcement and security agencies was carried out. This revealed nineteen problem areas of which eight appeared amenable to solution via the use of x-ray fluorescence methods. Of these, six were selected for further study on the basis of feasibility and the extent of potential use. The degree of technical and operational feasibility has been determined in each case and recommendations for further work are given. (auth)

39987 (PG-Report-832) ANALYTICAL METHOD FOR THE DETERMINATION OF PLUTONIUM BY AMPEROMETRIC TITRATION (ARGENTIC OXIDATION, FERROUS REDUCTION). Cherry, J.; Holmes, J.; Williams, J. J. B. (United Kingdom Atomic Energy Authority, Sellafield (England). Production Group). 1968. 12p. Dep. CFSTI. UK 1s. 9d.

The plutonium, in dilute sulfuric acid solution, is oxidized to plutonium(VI) with silver(II) oxide; excess of the oxidant is then destroyed with sulfamic acid. Plutonium(VI) is reduced to plutonium(IV) by adding a slight excess of a standard solution of iron(II). The excess is determined by titrating with a standard solution of potassium dichromate. The end points for reduction with iron(II) and oxidation with dichromate are obtained amperometrically with two platinum electrodes. There is no detectable bias and the coefficient of variation at the 40 mg level of plutonium is 0.035%. The method is applicable to the determination of plutonium in plutonium metal or oxide. It may also be used for the determination of plutonium in the form of chloride, fluoride, nitrate or sulfate and in alloys containing uranium and iron if the plutonium content is greater than 5%. Cerium, chromium, vanadium, manganese, and neptunium interfere quantitatively. (auth)

39988 (RFP-1146) COMPARISON OF QUANTITATIVE TECHNIQUES FOR ELECTRON MICROANALYSIS OF Pu-Ga AND Pu-Fe ALLOYS. Harvey, Malcolm R.; Riefenberg, David H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). May 29, 1968. Contract AT(29-1)-1106. 6p. Dep. CFSTI.

Examination of Pu-Ga and Pu-Fe alloys and compounds was carried out with an electron microprobe. The intensity-concentration relationships in both systems were found to quantitatively obey the empirical Ziebold Ogilvie equation. Utilization of this equation and its experimentally determined conversion parameter gave better quantitative results than those obtained using theoretically determined correction factors. (auth)

39989 (RT/PROT-(68)6) DETERMINAZIONI RADIOTOSSICOLOGICHE DI TORIO NATURALE, URANIO ARRICCHITO ED ATTIVITA BETA GLOBALE MEDIANTE TECNICHE DI CROMATOGRAFIA DI PARTIZIONE E FASI INVERTITE. (Determination of Radiotoxicology of Natural Thorium, Enriched Uranium, and Total Beta Activity by Means of Reversed-Phase Partition Chromatography). Testa, C.; De Rosa, D.; Salvatori, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 84p. (In Italian). Dep.

Some methods are described for determining natural thorium, enriched uranium, and total beta activity in urine by means of reversed-phase partition chromatography. Kel-F (polytrifluorochloroethylene) was used as the inert support and a solution of 0.5M tri-n-octylphosphine oxide (TOPO) in cyclohexane as the selective extractant for uranium and thorium. The urine was wet mineralized by boiling with HNO_3 and H_2O_2 and the solution passed through small Kel-F-TOPO columns; thorium was then eluted with dilute H_2SO_4, and uranium with 1M HF. Thorium was determined by colorimetry with Arsenazo III (ϵ = 130,000) was enriched uranium by alpha counting; furthermore these determinations can be achieved after a preliminary precipitation of phosphates for the beta counting of fission products in a low-background counter. (auth)

39990 (TID-24581) OPTIMAL NEUTRON ACTIVATION ANALYSIS. Eckhoff, Norman Dean (Kansas State Univ., Manhattan. Dept. of Nuclear Engineering). 1968. 197p. Dep. CFSTI.

Thesis.

Basic principles of neutron activation analysis, formulation of the problem, analysis for estimators, minimum absolute deviation (MAD) estimators, minimization of isotope production costs, optimal time parameters, spectrometer system, neutron source, and experimental procedures and results are discussed. A uniform irradiation and counting policy of 15 min irradiation at 50 kw power, 5 min decay, and a 3 min count yielded as much analysis information about a typical agriculture sample as any other policy. Seven elements, Cl, Mn, Mg, Ca, K, Br, and Na, can be determined in routine fashion for many agricultural samples. Gain and baseline stabilization by mathematical shifting of the reference and complex spectra were shown to be very important to the neutron activation analysis problem. Appendixes include: isotope buildup and decay, properties of estimators, maximum likelihood method of estimating parameters, the least squares method, Gauss-Markoff theorem, hypothesis testing, Pontryagin's maximum principle, computer program for the correlation algorithm, computer program for calculation of MAD estimators, and computer program for determination of optimal irradiation and decay times for both constant and exponential flux cases. (M.C.G.)

39991 (TRG-Report-1669) THE DETERMINATION OF HYDROGEN IN IRRADIATED ZIRCONIUM ALLOYS. Lambert, M. E.; Walker, J. A. J. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). Mar. 22, 1968. 9p. Dep. CFSTI. UK 2s.

A method is described for the determination of hydrogen in zirconium alloys by heating the sample to 1200°C and removing the liberated hydrogen in a stream of helium. The hydrogen is converted to water which is measured by an electrolytic hygrometer. A sample holder and furnace system which has been fully automated for routine analysis is also described. The coefficient of variation is not greater than 6% for samples weighing 0.1 to 0.25 g with hydrogen contents of 30 to 2000 ppM. (auth)

39992 CHOICE OF ANALYTICAL METHODS FOR INSTRUMENTAL ACTIVATION ANALYSIS. Egiazarov, B. G.; Zyubko, V. A.; Novikov, A. I. At. Energ. (USSR), 24: 435-7(May 1968). (In Russian).

The problem of the choice of analytical methods for the identification of radioactive isotopes of interest in specimens of complex-composition by activation analysis is discussed. The expression was obtained for the criterion of the choice of most optimal reactions for the radioactive isotope identification and of the time of irradiation, exposure, and measurement supposing that the spectrum consists exclusively of both a photopeak and a Compton distribution. An example is given of the calculation of method choice using the criterion obtained and the computer "Minsk 1." (auth)

39993 NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS FOR ROUTINE TESTING OF IMPURITIES IN SEMICONDUCTOR SILICON. Bogancs, J.; Quittner, P.; Szabo, E. At. Energ. (USSR), 24: 421-4(May 1968). (In Russian).

A method suitable for serial, nondestructive neutron activation analysis of silicon used for semiconductor production is described. The samples are irradiated by 10^{13} n/cm^2/sec thermal neutron flux for 24 to 28 hours. After 24 to 72 hours of cooling the gamma spectra are measured by scintillation detector and multichannel analyzer. For the spectrum decomposition a weighted least square computer program has been worked out. The usual contaminants of the analyzed samples are Cu, As, Sb, Na, Au, W, and P. The Cu content is determined in addition by coincidence measurement, while the P concentration is measured after 10 to 20 days by a betasensitive GM-counter, when correction is taken for the self-absorption of beta rays using a special formula. (auth)

39994 ABSOLUTE ISOTOPIC ABUNDANCE RATIOS OF COMMON, EQUAL-ATOM, AND RADIOGENIC LEAD ISOTOPIC STANDARDS. Catanzaro, E. J.; Murphy, T. J.; Shields, W. R.; Garner, E. L. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 261-7(May-June 1968).

Absolute values were obtained for the isotopic abundance ratios of common, equal-atom, and radiogenic lead isotopic standards using solid-sample mass spectrometry. Samples of known ^{208}Pb/^{206}Pb ratio, prepared from nearly pure separated ^{206}Pb and ^{208}Pb solutions, were used to calibrate the mass spectrometers. (auth)

39995 THE USE OF GELATING AGENTS IN ASSAYING SUBSTANCES LABELED WITH ^{14}C. Koeniger, M.; Suess, A. (Bayerische Landesanstalt fuer Bodenkultur, Pflanzenbau und Pflanzenschutz, Munich). Kerntechnik, 10: 274-8(May 1968). (In German and English).

There are difficulties in measuring insoluble samples in a liquid-scintillation spectrometer. By the use of gelling agents, solutions and colored samples could be measured with a good efficiency. The measuring sample remains constant for some days. There are considerable differences in the initial phosphorescence. Aerosil 300 showed the best properties in the experiments. (auth)

39996 VOLTAMMETRIC METHOD FOR DETERMINATION OF ZIRCONIUM. Zittel, H. E.; Florence, T. M. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Anal. Chem., 39: 355-6(Mar. 1967). (ORNL-P-2552).

A solution containing a mixture of free Alizarin Red S and its zirconium complex exhibits two discrete oxidation waves and the zirconium can be determined by measuring either the height of the zirconium–Alizarin Red S wave or the decrease in height of the free dye wave. Zirconium may be determined at concentrations as low as 0.1 ppM with simple polarographic apparatus. (M.C.G.)

39997 DETERMINING URANIUM AND PLUTONIUM IN ORGANIC SOLVENTS. Andreeva, M. M.; Bykovskii, N. N.; Chistyakova, G. A. At. Energ. (USSR), 24: 94-6(Jan. 1968). (In Russian).

Uranium and plutonium samples (200-ml volume) were extracted by phosphorylated cellulose (cation membrane 25 cm^2 in area) from a 20% TBP solution in kerosene after a 5-min contact time. The concentration range was 1 to 50 mg/l for U, and 0.005 to 0.1 mg/l for Pu. The membrane samples were rinsed, dried, and counted on a scintillation counter. The results showed that the count rate was a linear function of the concentration of ^{235}U or ^{239}Pu in the solution. Thus the data on the extraction of ^{235}U and ^{239}Pu from TBP solutions by phosphorylated cellulose show that it is possible to determine these elements quantitatively by comparison with count rates on solutions of known composition. Phosphorylated cellulose extracts ^{235}U and ^{239}Pu from ether and acetone, but not from other phosphonates and phosphinates which form strong complexes with these elements. (TTT)

39998 DETERMINATION OF THE FISSION PRODUCTS DISTRIBUTION IN COATED FUEL PARTICLES. Riedel, H. J.; Merz, E. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 260-3(May 1968). (In German and English).

A stepwise dissolution of the shells and of the fuel kernels of reactor-irradiated coated fuel particles was achieved by progressive digestion in oxidizing salt melts. The distribution profiles of the fission products in the shells and the radionuclides remaining in the fuel kernels were measured and evaluated by gamma spectroscopy of individual digestion fractions. The long-lived fission products ^{90}Sr, ^{95}Zr, ^{137}Cs, and ^{144}Ce were determined radiochemically after analytic chemical separation. (auth)

39999 ANALYSIS OF THE ISOTOPE MOLECULES OF HYDROGEN USING CAPILLARY COLUMNS AND AN ELECTROLYTIC CONDUCTIVITY DETECTOR. Mohnke, M. (Inst. for Stable Isotopes, Leipzig); Piringer, O.; Tataru, E. J. Gas Chromatogr., 6: 117-19(Feb. 1968).

A gas chromatographic apparatus is described with the aid of which it is possible to perform analyses of hydrogen isotope molecules in extreme concentration ratios. This is accomplished by the combination of a sharply separating adsorption-capillary column and a novel, highly sensitive electrolytic conductivity detector. Neon flows into a purification device which serves mainly to remove any water and carbon dioxide traces. It is followed by a sample injector having a sample volume of 2 μl, the capillary separation column, and the $PdCl_2$ reaction zone for transforming the test sample into gaseous HCl. The carrier gas stream then enters the electrolytic conductivity detector. The carrier gas and the conductivity water come in contact in the flushing capillary. The transfer of the gaseous HCl formed in the $PdCl_2$ microreactor into the aqueous phase takes place here. The aqueous and gaseous phases separate in the phase separator, and the pure carrier gas leaves the detector through a small side orifice while the aqueous solution flows past electrodes in the conductivity cell from which the signal is amplified and recorded. (BBB)

40000 SPECTROPHOTOMETRIC DETERMINATION OF RARE EARTH ELEMENTS WITH XYLENOL ORANGE IN THE PRESENCE OF CETYLPYRIDINIUM BROMIDE. Otomo, Makoto; Wakamatsu, Yoshinobu (Hachinohe Tech. Coll., Japan). Bunseki Kagaku, 17: 764-9(June 1968). (In Japanese).

Xylenol Orange reacts with rare earth elements(III) in an alkaline medium in the presence of cetylpyridinium bromide to form blue or bluish–violet chelates. These chelates have their absorption maxima at about 600 to 610 mμ. Maximum color developments are obtained in the pH range from 8 to 9. The sensitivities are very high, the molar absorptivities being about 1×10^5. The present method is applicable to the determination of traces of rare earth elements. Many metallic cations interfere with the determination. Some of the interfering cations, however, can be masked by addition of potassium cyanide or sodium fluoride. Results of the mole ratio method and of the continuous variation method, which are carried out in the presence of excessive cetylpyridinium bromide, indicate that 1 : 2 (metal : ligand) chelates are formed between rare earth elements(III) and Xylenol Orange. (auth)

40001 NEUTRON ACTIVATION MEASUREMENTS OF SILVER IN PRECIPITATION FROM LOCATIONS IN WESTERN NORTH AMERICA. Warburton, J. A.; Young, L. G. (Univ. of Nevada, Reno). J. Appl. Meteorol., 7: 444-8(June 1968).

Thermal neutron activation methods were applied to the determination of silver content in samples of hail, rain and snow. Hail and rain samples were collected in South Dakota in regions where AgI cloud seeding was being conducted; the snow was collected in the eastern Sierra Nevada in an area where no such seeding was being conducted. No silver was detected in the snow samples analyzed, indicating concentrations on the average less than 2.5×10^{-11} gm ml^{-1}. Eighty percent of the hail and rain samples analyzed contained measurable quantities of silver up to 70 times the minimum detectable amount. Some of these latter samples were collected in nominally unseeded areas. (auth)

40002 NEUTRON ACTIVATION PROCEDURES FOR SILVER ANALYSIS IN PRECIPITATION. Warburton, J. A.; Young, L. G. (Univ. of Nevada, Reno). J. Appl. Meteorol., 7: 433-43(June 1968).

Laboratory techniques were developed for concentrating and isolating silver from aqueous samples. When these concentrated samples are activated in a thermal neutron flux of 4×10^{12} n cm^{-2} sec^{-1}, quantitative measurements down to 10^{-9} gm masses of silver can be made. When 1-liter samples of water are used, the lower limit of detection of silver in the sample is about 3×10^{-12} gm cm^{-3} concentration. Typical Ag concentrations being observed in snow collected in the western United States range from this lower limit to 10^{-8} gm cm^{-3}; the majority are between 10^{-9} and 10^{-11}. The lower limit does not therefore appear to be a serious factor in silver determinations in snow collected at ground sta-

tions. The system described is a nondestructive one, the accuracy of measurement using γ-spectrometry being 1, 2, 10, and 80% for masses of silver 10^{-6}, 10^{-7}, 10^{-8}, and 10^{-9} gm, respectively. By using a 24-sec half-life radioisotope for the Ag determination, the cost of activation and turn-around time on samples is kept to a minimum. Data analysis is computerized and rapid. (auth)

40003 PHASE DISTRIBUTIONS OF THE RARE-EARTH ELEMENTS IN SEDIMENTS. Collins, Kenneth Alan. Madison, Wis., Univ. of Wisconsin, 1967. 192p.

The absolute rare earth concentrations in five sediments and their component mineral phases were determined by neutron activation analysis. The samples included the Byron Formation Dolomite, the Oneota Dolomite, the St. Peter Sandstone, the Sunset Point Sandstone (all of Wisconsin) and the Coaledo Formation Graywacke (of Oregon). The component mineral phases were obtained using dry (non-chemical) techniques such as heavy liquid and magnetic separation, to prevent alteration of the rare earth absolute and relative abundances by chemical effects. The rare earth distributions in all five sediments showed no radical departure from the average rare earth distribution of the weathered portion of the earth's crust. Greater variation was discovered among component minerals of these rocks. In those sediments that contained small amounts of accessory minerals (e.g., 0.05% heavy minerals), the bulk of the rare earths was found in the rock-characterizing mineral (quartz in sandstone, dolomite in dolomite), despite the relatively low rare earth concentration (10 ppM) in this mineral. As the amounts of feldspar, mica, organic matter, and clay increased in a sediment, the rare earth content also rose and the rock-characterizing mineral no longer accounted for the major portion of the rare earths in the sediment. Evidence was found that quartz and dolomite from different sediments may each have fairly uniform absolute and relative rare earth abundances. There are also indications that hematite is enriched in the heavy rare earth elements compared to the sedimentary crustal average. A material balance for the rare earths was constructed for each sediment, based upon the rare earth contents of the component mineral phases. Explanations are given of how the different rare earth patterns of constituent minerals contribute to the overall pattern of the whole rock. The results are consistent with Goldschmidt's hypothesis that the similarity of rare earth patterns in very different sediments arises from the thorough mixing of weathered crustal material in the oceans over geologic time. (Disser. Abstr.)

40004 DETERMINATION OF HEAVY METALS BY ISOTOPE TITRATION. Fuchs, A. (Univ., Zurich). Deut. Z. Gesam. Gerichtl. Med., 57: 310-12(1966). (In German).

If an insufficient amount of a complexing agent is added to a mixture of several ions, the most reaction will be those ions that form the most stable complexes. Thus in the reaction of EDTA with Pb and Co, the Pb will complex first, then when nearly all the Pb is complexed, the Co will react. By using labeled Co and electrophoretic separation of the negatively charged complex from the free ion, the formation of the Co complex can be followed and used to determine the amount of Pb present. Details of an experimental procedure for Pb are given; the method can in principle be applied to any metal whose EDTA complex has a stability constant greater than $10^{16.3}$. The method can also be used for isotope dilution analysis in the substoichiometric sense; for several elements it should be more sensitive than neutron activation analysis. Nanogram amounts of Pb and Hg can be determined. (BBB)

40005 CONTRIBUTION TO THE PROBLEM OF NEUTRON SELF-ABSORPTION IN ACTIVATION ANALYSIS. Prouza, Z.; Rakovic, M. (Veterinary Research Centre, Prague. Karlova Univ., Prague). Atompraxis, 14: 245-7(June 1968).

It is relatively easy to evaluate neutron self-absorption in spherical samples. The spherical sample is often assumed in spite of the fact that the real shape of the sample is irregular. The influence of this irregularity is considered. The rotation ellipsoid was examined as an example. When the ratio of its axes is substantially different from 1 such a body may be taken as being much more different from the sphere than is the real sample. The results show that the magnitude of the relative error caused by the assumption of a spherical shape is often lower than 5% in the "1/v"-region, as well as in the resonance-peak region. (auth)

40006 RADIOCHEMICAL DETERMINATION OF ^{137}Cs IN ORGANIC SUBSTANCES. Benes, J.; Tomasek, M. (Institut fuer Kernforschung, Prague). Atompraxis, 14: 259-62(June 1968). (In German).

Chemical preparation of the ashes of organic substances for isolating ^{137}Cs in the presence of other uranium fission products and a high K content is reported. Results are given for tests on the precipitation of cesium with hexachloroplatinic acid and sodium tetraphenyl borate, the coprecipitation of cesium ions with Berlin blue, and the exchange of ammonium molybdophosphate and ammonium tungstophosphate in a column arrangement. A simplified working method is suggested for isolating ^{137}Cs from organic substances. (auth)

40007 STATISTICAL ESTIMATION OF PRECISION OF THREE METHODS FOR THE DETERMINATION OF THE RADIOCHEMICAL PURITY OF CARRIER-FREE Na ^{131}I PREPARATIONS. Pasternak, A. (Kernforschungsinstitut, Swierk, Poland). Isotopenpraxis, 4: 137-8(Apr. 1968). (In German).

Three methods were compared for determining the radiochemical purity of Na^{131}I paper and thin layer chromatography and electrophoresis. The analysis of variance showed that the most precise and suitable method for the purpose of precision is electrophoresis. (auth)

40008 RESONANCE NEUTRONS IN ACTIVATION ANALYSIS. PART 3. DETERMINATION OF GOLD IN CADMIUM TELLURIDE. Rakovic, M.; Prouza, Z. (Karlova Univ., Prague. Veterinary Research Centre, Prague). Isotopenpraxis, 4: 138-40(Apr. 1968).

An activation method for determining gold in cadmium telluride is described. The sample is covered by a Cd-filter and activated in the core of a nuclear reactor. After activation, chemical separation (consisting of three steps) and measurement by a scintillation counter is carried out. (auth)

40009 CONTINUOUS MEASUREMENT OF RADIOACTIVITY IN PARALLEL OPERATION CHROMATOGRAPHICAL STUDIES. Bernhardt, C. (Forschungsinstitut fuer Tuberkulose und Lungenkrankheiten, Berlin). Isotopenpraxis, 4: 143-5(Apr. 1968). (In German).

Separation processes by column chromatography are profitably carried out in parallel operation of several columns with the activity of the column eluates being continuously recorded. An arrangement is described making possible the realization of this technique. The outlet tubes of two chromatographic columns were alternately placed between two G-M counters in parallel connection by means of a changer manufactured for this purpose. The counting rate was measured by a radiation detector and recorded by a three-color recording potentiometer. The arrangement was directed by a modified commercial fraction collector. (auth)

40010 POLAROGRAPHIC MICRODETERMINATION OF FLUORIDE. Bond, A. M.; O'Donnell, T. A. (Univ. of Melbourne, Victoria). Anal. Chem., 40: 1405-7(Aug. 1968).

A rapid, highly specific polarographic method, based on shift of the uranium(V)–uranium(III) half-wave potential, was developed for precise determination of fluoride in the concentration range 2.5×10^{-6} to 10^{-3}M (0.05 to 20 ppM). Because the method requires no prior separation or concentration of the fluoride, it is particularly applicable to analysis of potable waters. With simple modification, it can be used to determine higher fluoride concentrations. It was applied successfully to the analysis of a wide range of inorganic fluorides. (auth)

40011 MECHANISM OF THE SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM WITH THIOCYANATES. Djordjevic, Cirila; Tamhina, Biserka (Faculty of Science, Zagreb). Anal. Chem., 40: 1512-15(Aug. 1968).

Systems containing niobium(V) in acid media with excess of thiocyanates, imitating the conditions for the spectrophotometric determination of niobium, were investigated. Several colored species contribute to the absorbance of such solutions, measured in the vicinity of 380 mμ. A yellow crystalline substance, which did not contain the metal, was formed by thiocyanate polymerization in acid media and separated from aqueous and organic phase. This substance was characterized as isoperthiocyanic acid, $C_2H_2N_2S_3$. Presence of hexathiocyanato niobate(V) and oxopentathiocyanato niobate(V) in these solutions was established. Shortcomings of the spectrophotometric determination of niobium with regard to optical instability and variation of color intensity are explained by the isoperthiocyanic acid formation, as well as by stepwise formation of colored thiocyanato niobates(V). (auth)

40012 HIGH-CURRENT IMPULSE ARGON ARC METHOD FOR THE SPECTROGRAPHIC ANALYSIS OF MICROSAMPLES. Svoboda, Vratislav; Kleinmann, Imrich (Inst. for Research, Production, and Use of Radioisotopes, Prague). Anal. Chem., 40: 1534-40(Aug. 1968).

A spectrographic technique employing the wall-stabilized, short-lasting, high current (60 A) argon arc for excitation is described. Weight of samples should not exceed 400 μg. Contamination by the radioactive sample is eliminated as the excitation is performed in a closed vessel. The limit of detection for Sr in the more sensitive variant of analysis is 0.0005 ng; in

the less sensitive one, 0.003 ng. Other limits of detection are: for Ag, Be, Cu, Ti, Y, and Yb, 0.01 to 0.09 ng, for Eu, Mn, Sc, Tm, and Zr, 0.01 to 0.4 ng, for Ba, Dy, Er, Na, Mo, La, Ho, Pd, Tb, and Zn, 0.5 to 1 ng; for Co, Bi, Gd, Fe, Ni, Cd, Lu, In, Cr, Rh, Th, and V, 1 to 3 ng; for Au, B, Nd, Pb, Pr, Pt, Sb, Sm, Sn, and Tl, 4 to 10 ng; for W and As, 10 to 40 ng; and for Te, 60 ng. A 2 m spectrograph with 325 grooves/mm grating and blaze angle 19° is used so that at one exposure a broad spectral region (2000 to 5400 Å) with reciprocal dispersion from 1.5 to 3.5 Å/mm is covered. For arc sources burning in argon and oxygen atmospheres at discharge currents varying from 10 to 90 A, the high-current arc sources ensure low limits of detection and lower matrix effects than low current arcs. In an argon atmosphere, the line intensity is about twofold for most elements in comparison with that of oxygen. (auth)

40013 COMPUTATION OF LITHIUM-DRIFTED GERMANIUM DETECTOR PEAK AREAS FOR ACTIVATION ANALYSIS AND GAMMA RAY SPECTROMETRY. Yule, Herbert P. (Texas A and M Univ., College Station). Anal. Chem., 40: 1480-6(Aug. 1968).

Results of studies of net full energy peak area computation methods for activation analysis and gamma ray spectrometry are reported. Using a computer routine to search for any and all peaks in the spectrum, peak boundary channels were located by studying the behavior of a smoothed spectrum and a smoothed first derivative spectrum, each formed from the original spectrum. Net peak areas were computed from that portion of the spectrum enclosed by the peak boundary channels, overcoming changes in peak shape due to resolution losses and to other causes. This method gave accurate results for activation analysis, decay curve resolution, and other peak intensity studies. (auth)

40014 ANTI-QUENCH SHIFT IN LIQUID SCINTILLATION COUNTING. Gordon, B. E.; Curtis, R. M. (Shell Development Co., Emeryville, Calif.). Anal. Chem., 40: 1486-93(Aug. 1968).

An increase in efficiency (anti-quench shift) was observed in liquid scintillation counting of samples containing optically diffusing white materials or surfaces. Theoretical calculations and experiments support the hypothesis that the enhanced efficiency results from a reduction in the amount of light lost through total internal reflection. The effect is equivalent to a shift in pulse height spectrum and can be allowed for by the usual methods of efficiency calibration except for the external standard total count method which is not satisfactory. (auth)

40015 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM WITH 2,4,6-TRI(2'-PYRIDYL)-s-TRIAZINE. Embry, Wallace A.; Ayres, Gilbert H. (Univ. of Texas, Austin). Anal. Chem., 40: 1499-1501(Aug. 1968).

Ruthenium(III) reacted with 2,4,6-tri(2'-pyridyl)-s-triazine (TPTZ) in water–alcohol solution at pH 2.2 to 4.0 to give a red-purple solution having an absorption peak at 510 mμ. Full color development required heating at 87°C for one-hour; the color was stable for more than 12 hours. The system conforms to Beer's law; optimum range for measurement at 1.00 cm optical path is about 1 to 4 ppM of ruthenium. Common anions did not interfere; separation from interfering cations was effected by distillation and recovery of ruthenium tetroxide. A reaction ratio of ruthenium to TPTZ of 1 to 2 was determined by the methods of continuous variations and mole ratio. Isolation and elemental analysis of the picrate and the perchlorate of the cationic complex confirmed the 1 to 2 reaction ratio. (auth)

40016 OXYGEN ISOTOPES OF SOME MINERALS FROM THE CARBONATITES OF THE FEN AREA, SOUTH NORWAY. Fredrichsen, Hands (Univ., Marburg/Lahn, Ger.). Lithos, 1: 70-5 (1968). (In German).

The genesis of carbonatite minerals was studied on the basis of $^{18}O/^{16}O$ ratios, the ratio of magmatic carbonate rocks ranging from +6 to +8‰ compared to standard mean ocean water. The ^{18}O content was determined in calcite, dolomite, ankerite, and hematite of 3 types of carbonatite. For the carbonates of sövite and rauhaugite the ratio of $^{18}O/^{16}O$ ranged from 6.9 to 8.2 per mil. These values indicate a magmatic origin (~600 to 700°C). For rödbergite the ratio in carbonates is in the range 12.6 to 15.4 per mil. Two determinations on hematite from Rödbergite gave −2.4 and 0.75 per mil. Rödbergite thus seems to be a metasomatic alteration product of rauhaugite, with a temperature of formation ~200°C. (BBB)

40017 PHOTOMETRIC DETERMINATION OF THORIUM WITH QUINALIZARIN AND BUTYL CELLOSOLVE. Barra F., T.; Seeger S., B. (Univ. Concepcion, Chile). Rev. Real Acad. Cienc. Exact. Fis. Nat. Madrid, 61: 827-45(1967). (In Spanish).

A technique for the photometric determination of Th by quinalizarin using butyl cellosolve to maintain a stable suspension of the lake and acetate control of the pH is described. Solvents of the cellosolve type have stabilizing properties towards metallic lakes, forming very stable solutions. Other advantages of cellosolves are low volatility, and their high dissolving power. With butyl cellosolve NaOH or H_2SO_4 is no longer needed to effect solution of quinalizarin. The method is compared with the two-wave procedure of Balabanoff and Zelada, and a calibration curve is constructed. Better results are obtained than with a simple calibration curve, but different constants are employed for different ranges of concentration. The method is applicable in the 20 to 250 μg range for Th. Derivation of the necessary equations for experiments is given, and the history of photometric determinations of Th is reviewed. (BBB)

40018 INTERFERENCE OF SOME RADIOACTIVE IMPURITIES WITH THE LIQUID SCINTILLATION DETERMINATION OF ^{239}Pu IN AQUEOUS SOLUTIONS. Joon, K.; Deurloo, P. A. (Inst. for Atomenergi, Kjeller, Norway). J. Radioanal. Chem., 1: 73-6(Jan. 1968).

In liquid scintillation counting for the determination of α-active nuclides, because of the low light output of α particles in comparison with that from β particles, the latter may interfere with the determination. The difference in the energy spectra, i.e., a continuous β spectrum vs a line-spectrum for α particles, offers the possibility for a reduction of this interference by discrimination. To apply this method in routine determination of Pu in a fuel reprocessing plant, the influence on this determination of natural U and the fission products (FP) ^{144}Ce, ^{137}Cs, ^{106}Ru, and ^{95}Zr, all in equilibrium with their respective decay products, was studied. From the maximum β energies of the various FP, the order of the efficiency, e, was $^{137}Cs > {}^{144}(Ce + Pr) > {}^{106}(Ru + Rh) > {}^{95}(Zr + Nb)$. How variations in the α/β intensity ratio which may cause changes in the widths of the channel is shown. For natural U as the contaminant (in equilibrium with its β-active daughters and with a sp α activity of 1493 cpm/mg U), e was measured as 1260 cpm/mg U, independent of both the U/Pu ratio (r) and quenching conditions. The influence of quenching by HNO_3 is demonstrated. The error introduced into the Pu determination by the U could be calculated from a relation which was given. If higher accuracies are required than obtainable by this method, or as an alternative method, a preliminary separation of Pu and the contaminants may be necessary. It was possible to determine Pu with an accuracy of 1% in a 3M HNO_3 solution, containing 70 mg of Pu, 300 g of U, and about 5 Ci of mixed FP per l, by extracting the Pu from this solution with trilauryl amine. The organic phase was counted after scrubbing with 4 to 5M nitric acid. (BBB)

40019 AUTOMATIC CALCULATION OF SPECIFIC ACTIVITIES FROM LIQUID SCINTILLATION COUNTER DATA USING A DESK-TOP COMPUTER. Scott, B. F. (New England Nuclear Assay Corp., Boston). J. Radioanal. Chem., 1: 61-71(Jan. 1968).

Problems encountered in calculating the sp activities of a large number of radioisotope-labeled organic compounds on a routine basis are considered and a method described which uses a desk-top computer to calculate the absolute sp activities of batches of the labeled chemicals. Errors and operator fatigue were reduced and reporting was speeded due mainly to the elimination of hand-transcribing of results. Other advantages were that tedious calculations of the absolute activities of double-labeled compounds were as easy to perform as for single-labeled compounds, and that samples having identical dilution parameters can be calculated without any manual manipulation at all. Programming methods are explained. (BBB)

40020 NONDESTRUCTIVE DETERMINATION OF HAFNIUM BY NEUTRON ACTIVATION AND γ SPECTROMETRY OF ^{178m}Hf AND ^{178m}Hf (RESPECTIVE PERIODS: 19.0 AND 4.8 SEC): THEORETICAL STUDY: APPLICATIONS ON ZIRCONIUM AND VARIOUS ALLOYS. Haerdi, W.; Balsenc, L.; Monnier, D. (Univ., Geneva). J. Radioanal. Chem., 1: No. 1, 51-9(Jan. 1968). (In French).

Use of a neutron activation method for estimation of Hf was explored. Radioisotopes arising from thermal neutron irradiation of natural Hf are tabulated, with their half-life times, γ-ray energies, and sensitivity of estimation (in cps). The neutron activation technique that was developed for the determination of Hf in Zr and various alloys is based on the formation of ^{178m}Hf and ^{179m}Hf. For a neutron flux of 10^9 n·cm^{-2}·sec^{-1} the limit of determination is about 0.5 μg. This limit is as low as 50 ng with a multiple irradiation system (10 runs at 92-sec cycles). A determination is complete within 15 min, but in the multiple irradiation method about 15 min longer is required. (BBB)

40021 REDOX METHODS WITH NEUTRON-ACTIVATED SILVER METAL (^{110m}Ag) AS A RADIOREAGENT. Illaszewicz, A.; Mueller, K.; Rabussay, D.; Spitzy, H. (Technische Hochschule, Graz). J. Radioanal. Chem., 1: 39-49(Jan. 1968). (In German).

A new analytical method using ^{110m}Ag is described in which a known amount of excess oxidant is applied to the reducing agent that is to be determined. After the reaction has taken place, excess oxidizing agent is reacted with the neutron-activated Ag whereby ^{110m}Ag ions are released. The count rate of the solution is proportional to the excess of the oxidant; thus it is possible to determine the original content of the reducing agent in question. The proposed redox procedure based on back measurements was applied to determinations of hydrogen peroxide, sodium oxalate, potassium ferrocyanide(II), uranium(IV), as well as hydroquinone and ethanol in the μg range. The method makes use of calibration curves; the standard deviation is ±2% on the average. Magnitudes of the normal potentials of the system involving favorable reaction conditions, and kinetics are discussed. (BBB)

40022 TWO RADIOMETRIC METHODS FOR THE FAST DETERMINATION OF CALCIUM IN CEMENT RAW MIX. Lubecki, A.; Wasilewska, M. (Inst. of Nuclear Tech., Krakow). J. Radioanal. Chem., 1: 25-37(Jan. 1968).

Fast determination of calcium in cement raw mix is a very important problem from the economic point of view. In order to solve this task, the following two methods are proposed: non-dispersive x-ray fluorescence analysis (using ^{109}Cd as a source of primary radiation) and back-scattering of β-particles (using ^{90}Sr + ^{90}Y as a source). The influence of the following factors was studied in both methods: concentration of iron in the matrix; water content; and grain size of the sample. The influence of the energy of the primary radiation on the slope of a calibration curve has been analyzed in the fluorescence method. In the concentration range of 42 to 52% CaO, the absolute standard error is 0.17% CaO in the fluorescence analysis, and 0.5% CaO for the method of back-scattering of β-particles. The average time of a determination is about 2 min. (auth)

40023 RADIOCHEMICAL DETERMINATION OF FISSION PRODUCTS OF URANIUM. Cornelis, R.; Speecke, A.; Hoste, J. (Univ. of Ghent). J. Radioanal. Chem., 1: 5-24(Jan. 1968).

An analytical technique was developed for determining the long-lived γ-emitting U fission products in reactor fuel. It consists of a sodium bisulfate melt of the fission product solution or the U fuel, followed by liquid–liquid extractions. Then the isotopes are counted with a standardized 3 × 3 in. NaI crystal. The total γ spectrum of the original fission product solution obtained with a NaI crystal or a Ge–Li detector, is also analyzed mathematically by mixed γ spectrometry. The concentrations of both ^{235}U and ^{238}U are determined. The absolute amount of fission products related to the U concentration allows the concentration of the percent fuel burnup, the irradiation time, the cooling period, the flux of the reactor, and the original degree of enrichment of the U. (BBB)

40024 CARBON-14. Raaen, Vernon F.; Ropp, Gus A.; Raaen, Helen P. McGraw-Hill Series in Advanced Chemistry. New York, McGraw-Hill Book Co., 1968. 397p. $15.00.

The principles, experimental techniques, and typical applications of ^{14}C are discussed. Emphasis is on reaction mechanisms and the use of ^{14}C as an analytical tool. Topics covered include: the radioisotope ^{14}C, isotope-dilution and related analytical methods, location of carbon atoms, isotope exchange, kinetic isotope effects, radiation chemistry and nuclear effects, radiation hazards and protection, synthesis of ^{14}C-labeled compounds, degradation, assay of ^{14}C compounds, chromatography, autoradiography, mass spectrometry, and model experiments. (M.C.G.)

40025 ANALYTICAL CHEMISTRY OF ZIRCONIUM AND HAFNIUM. Drexler, Edward James. Detroit, Wayne State Univ., 1964. 60p.

Thesis.

A study was made of the zirconium and hafnium complexes of rufigallic acid to determine their usefulness in determining zirconium–hafnium ratios. Both metals form a 1:1 complex with rufigallic acid with a maximum absorbance at 560 mu. The complexes were found to be almost completely identical in their reactions. The effects of acidity on the complex were determined. Optimum color development was obtained in 0.5 N acid solution. The effects of heating and time of standing were determined for the complexes. The complexes conform to Beer's Law over the range of 2 to 7 ppM. The complexes were found to be stable for approximately one hour. Since both complexes react identically, they could not be used for the determination of zirconium–hafnium ratios. The use of EDTA to determine zirconium–hafnium ratios was studied. The optimum conditions for the standardization of the EDTA solutions and for the titration of the zirconium–hafnium mixtures were determined. The method consisted in a standardization against pure hafnium oxychloride, an indirect procedure with bismuth as the back-titrant. The indicator used was xylenol orange. The procedure was applied to a series of synthetic mixtures of zirconium and hafnium. The accuracy is approximately 0.5% absolute over the range 90 to 20% hafnium oxide. An attempt was made to apply the procedure to commercial zirconyl chloride. The results obtained were erratic. A number of factors were studied in an attempt to obtain reliable results. None of these were successful. (Disser. Abstr.)

40026 A RADIOMETRIC PROCEDURE FOR THE MICRO DETERMINATION OF PALLADIUM AND IODIDE WITH ^{131}I. Purkayastha, Usha; Maity, H. P. (Saha Inst. of Nuclear Physics, Calcutta). Analyst, 93: 371-4(June 1968).

The principle of the method depends on the formation of labelled palladium(II) iodide by addition of an excess of a solution of potassium iodide containing iodine-131 to the palladium solution. The palladium(II) iodide is then carried by zirconium hydrogen orthophosphate, $Zr(HPO_4)_2$, formed in the solution. From the loss of iodine-131 by the solution the amount of palladium can be determined. By using the same principle, iodide can be determined if a known amount of palladium is added. The adsorption of palladium (II) iodide by zirconium hydrogen orthophosphate was found to be selective. Amounts of palladium in the range 4×10^{-3} to 2×10^{-7} g were determined, and errors were always within statistical fluctuations in activity measurements. The effect of the presence of some foreign ions was studied. The method is simple and can be completed within 30 minutes. (auth)

40027 STABLE CARBON ISOTOPES IN THE DISSOLVED ORGANIC MATTER OF THE SEA. Williams, P. M. (Univ. of California, La Jolla). Nature (London), 219: 152-3(July 13, 1968).

Determinations were made of the $^{13}C/^{12}C$ ratios in dissolved organic matter. The dissolved organic carbon was converted to CO_2 for mass spectrographic analysis by photooxidation with high energy uv radiation, and the experimental procedure is briefly described. Results are tabulated. A uniform distribution of $\delta\ ^{13}C$ with depth was found. There was no correlation between $\delta\ ^{13}C$ and water temperature, dissolved oxygen, or total dissolved organic carbon. The isotopic ratios found in the dissolved organic matter closely approximated those of the cellulose and lignin fractions of phyto and zooplankton samples. The uniform distribution of $\delta\ ^{13}C$ in the dissolved organic carbon with depth supports the hypothesis that deep water organic matter is stable with respect to chemical and biochemical oxidation, and suggests that this matter is derived from the cellulose and lignin fractions of the plankters–also that the more labile proteins and carbohydrates are biochemically oxidized and utilized in the upper several hundred metres of the ocean. (UK)

40028 DETERMINATION OF ^{207}Pb BY NUCLEAR MAGNETIC RESONANCE. Fujiwara, Shizuo (Tokyo Univ.); Ogimura, Yoshiko; Nagashima, Kozo. Chem. Instrum., 1: 21-32(July 1968).

To investigate an alternative to the method of determining the relative abundance of isotopes by mass spectroscopy or x rays, use of the structure of satellites accompanying the proton magnetic resonance spectra of metal chelates is proposed. In particular, the relative abundance of the ^{207}Pb isotope was determined by the NMR method. The proton NMR spectrum of aqueous solutions of lead-EDTA chelate presents two signals corresponding to ethylenic and acetate protons. Each of these is accompanied by a pair of symmetric satellites, due to the coupling of these protons with ^{207}Pb. Since other lead isotopes, 204, 206, and 208, have zero spin quantum numbers, they give a single line at the center of the satellites. The isotopic abundance of ^{207}Pb can be determined by a comparison of the relative intensities of the satellites and the central line. A detailed examination of the experimental conditions was performed to find the most suitable conditions for measurements. This method was applied to commercially obtained lead salts and to lead extracted from minerals, such as cerussite and uraninite. (auth)

40029 SEPARATION OF ^{95}Zr AND ^{95}Nb BY MEANS OF EXTRACTION CHROMATOGRAPHY. Caletka, Rostislav (Inst. of Nuclear Research, Prague). Chem. Listy, 62: 669-73(June 1968). (In Czech).

The possibility of using BPHA (N-benzoylphenylhydroxylamine), TTA (thenoyltrifluoroacetone), and D2EHPA [bis(2-ethylhexyl) ester of phosphoric acid] for separating ^{95}Zr from ^{95}Nb by extraction chromatography was investigated. The method permits separating radiochemically pure ^{95}Zr and analysis of ^{95}Zr–^{95}Nb mixtures. The method permits simultaneous analysis of various specimens. (tr-auth)

40030 REMOTELY OPERATED EQUIPMENT FOR THE ANALYSIS OF REPROCESSING SOLUTIONS. Moeken, H. H. Ph.;

Sitte, R.; Heinz, W.; Keese, H. (Eurochemic, Mol, Belgium). J. Radionanal. Chem., 1: 113-22(Mar. 1968).

Laboratory apparatus used for analysis of highly radioactive solutions produced by the Eurochemic plant in the chemical reprocessing of irradiated fuel, is described briefly. Analyses of the samples, which contain high concentrations of γ-emitting nuclides and plutonium, must be carried out in lead-shielded airtight boxes because of the radiation exposure hazard. A description of the remotely operated equipment for aliquot pipetting, density determination, potentiometric titration, extraction, dilution, and colorimetric determination is given. (auth)

40031 SEPARATION OF ALKALI METALS BY EXTRACTION CHROMATOGRAPHY WITH DIPICRYLAMINE AND NITROBENZENE. Kyrs, M.; Kadlecova, L. (Inst. of Nuclear Research, Rez, Czech.). J. Radioanal. Chem., 1: 103-12(Mar. 1968).

An extraction chromatographic method to separate rubidium and cesium using a nitrobenzene solution of ammonium dipicrylaminate was developed. The procedure is used in connection with a concentration-dependent radioisotope distribution method for determining traces of cesium in rubidium salts. A frontal chromatographic enrichment method to eliminate excess sodium, lithium, and calcium salts was worked out. The results are compared with the conclusions drawn from the extraction mechanism and with other separation procedures. (auth)

40032 DETERMINATION OF DYSPROSIUM, EUROPIUM, SAMARIUM, AND GADOLINIUM IN YTTRIUM OXIDE OF HIGH PURITY BY MEANS OF NEUTRON ACTIVATION ANALYSIS. Alimarin, I. P.; Jakovlev, Yu. V.; Miklishanskii, A. Z.; Dogadkin, N. N.; Stepanets, O. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). J. Radioanal. Chem., 1: 139-45(Mar. 1968).

Radioactivation analysis allows determination of individual rare earth element impurities in rare earth elements of high purity. The determination of dysprosium, europium, samarium, and gadolinium in yttrium oxide is complicated by the short half-life of ^{165}Dy (138 min) and by the difficulty of separating traces of these elements from the matrix. A chromatographic method was developed, for the separation of traces of Dy, Eu, Sm, and Gd from yttrium, on a column packed with anion exchanger AV-17, by elution with 0.1N and 0.3M solutions of EDTA–sodium salt, followed by separation of the mixture of rare earth impurities on a microcolumn of cation exchanger KU-2, using a 0.17M solution of ammonium α-hydroxyisobutyrate as the eluent. The sensitivity of the determination of Dy, in the case of irradiating 10 mg of Y_2O_3 with a flux of 1.2×10^{13} n·cm^{-2}·sec^{-1} for 5 min was 1×10^{-7}%; the corresponding values for Sm, Eu, and Gd, when irradiating a 100-mg sample of Y_2O_3 for 20 hours with the same flux, were 2×10^{-7}, 1×10^{-8}, and 5×10^{-6}%, respectively. (auth)

40033 ACTIVATION ANALYSIS OF CHROMIUM IN WATER MATRIX. Lima, F. W.; Silva, C. M. (Instituto de Energia Atomica, Sao Paulo, Brazil). J. Radioanal. Chem., 1: 147-52 (Mar. 1968).

Chromium at concentrations of parts per billion in water, may be determined by activation analysis using an instrumental method preceded by concentration on anion exchange resins. Blank runs, using deionized water, are carried through the steps of preconcentration. The blank-resin and sample-resin are irradiated together with thermal neutrons, and the gamma spectrum of each is stored in half of the memory unit of a multichannel analyzer. Subtraction of the blank-resin spectrum from the sample-resin spectrum gives the ^{51}Cr peak free from interfering activities. (auth)

40034 RADIOMETRIC DETERMINATION OF IONIC CHLORINE AND OXYGEN IN WATER. Beaudet, C.; Rygaert, J. (SERAI, Brussels). J. Radioanal. Chem., 1: 153-61(Mar. 1968).

Two portable devices for the radiometric analysis of industrial water are described. Chlorides are precipitated by a known volume of standard silver nitrate labeled with ^{110m}Ag; the decrease of activity is proportional to the amount of ionic chlorine. Determination of dissolved oxygen is achieved by dissolution of radioactive thallium, and the activity of the effluent is directly related to the concentration of oxygen. (auth)

40035 ISOTOPE DILUTION ASSAY FOR DEXAMETHASONE IN PHARMACEUTICAL PREPARATIONS. Rosenblum, C.; Meriwether, H. T. (Merck Sharp and Dohme Research Labs., Rahway, N. J.). J. Radioanal. Chem., 1: 163-7(Mar. 1968).

The determination of 9-α-fluoro-16-α-methylprednisolone (dexamethasone) in drugs using the isotope dilution method is described. Dexamethasone is tritiated with tritium-labeled acetic acid and in the course of the isotopic dilution the activity of tritium is measured with a liquid scintillator. (auth)

40036 SELECTIVE REMOVAL OF RADIO-SODIUM FROM NEUTRON-ACTIVATED MATERIALS BY RETENTION ON HYDRATED ANTIMONY PENTOXIDE. Girardi, F.; Sabbioni, E. (Euratom Joint Nuclear Center, Ispra, Italy). J. Radioanal. Chem., 1: 169-78(Mar. 1968).

A new method is presented for removal of sodium interferences from neutron-activated materials. The method is based on passage of the samples, dissolved in a concentrated acid solution on a column of hydrated antimony pentoxide (HAP). The retention is quantitative with a maximum capacity of 31 mg Na/g HAP. Only tantalum, in addition to sodium, was retained by HAP out of the 60 elements tested. The method should find applications in neutron activation analysis, particularly of biological materials. Applications are also foreseen in other analytical techniques, such as emission spectroscopy and flame spectrophotometry, where high sodium concentrations in the sample can be a source of interference. (auth)

40037 SPECTROPHOTOMETRIC DETERMINATION OF CERIUM(III) WITH CHROME AZUROL S. Horiuchi, Yoshizo; Nishida, Hiroshi (Iwate Univ., Ueda, Japan). Bunseki Kagaku, 17: 824-9(July 1968). (In Japanese).

A small amount of cerium was determined spectrophotometrically with Chrome Azurol S(CAS). Two milliliters of 0.25% CAS solution was added to 10 to 15 ml of the acidic solution containing cerium, and pH was adjusted to 6.40 with 7% hexamine solution. After a dilution to 25 ml with water and allowing to stand for 10 min., the absorbance was measured at 510 mμ against the reagent blank. The absorbance obeyed Beer's law over 5 to 120 μg Ce/25 ml, and the apparent molar absorptivity was 1.83×10^4. By a separation of cerium as fluoride from di-, tri-, and tetravalent cations with sulfuric acid and hydrofluoric acid, interfering cations were removed except for lanthanum and yttrium, which were colored intensely at pH 9.60 with CAS where cerium was colored very slightly. Then 10 to 200 μg of cerium, 7 to 142 μg of lanthanum, and up to 60 μg of yttrium were determined simultaneously by measuring the absorbances at 510 mμ (pH 6.4), 610 mμ and 560 mμ (pH 9.6), respectively. (auth)

40038 RADIOACTIVATION ANALYSIS OF SILICON AND ALUMINUM WITH 14 MeV NEUTRONS. Tsuji, Haruo; Kusaka, Yuzuru (Konan Univ., Higashinada, Japan). Bunseki Kagaku, 17: 864-70(July 1968). (In Japanese).

A rapid and nondestructive activation analysis of silicon and aluminum in silicate was proposed, by means of ^{28}Si(n,p)^{28}Al and ^{27}Al(n,p)^{27}Mg reactions caused by 14-MeV neutron irradiation. A sample (3g) in a polyethylene rabbit and a quartz neutron monitor were irradiated simultaneously for 3 min. with 14 MeV neutrons produced by T-d reaction in a Cockcroft–Walton neutron generator, and then the induced radioactivities were measured by a well type scintillation detector. A multichannel analyzer or two single-channel pulse height analyzers were used for counting the ^{28}Al and the ^{27}Mg photopeaks. One minute's counting after 3.5 min. cooling was adopted for silicon, and 3 or 4 min. counting after 25 min. cooling for aluminum. The radioactivities were normalized with the activity induced in the monitor, and then silicon and aluminum were determined, referring to the calibration curve. The determination of aluminum was interfered from ^{56}Mn introduced by (n,p) reaction of iron as a sample constituent, and the result should be corrected for this by counting ^{56}Mn at 1 hr. after the ^{27}Mg counting. The analytical errors by this method were 2% for silicon and 4% for aluminum, under the neutron flux 1×10^7 n/cm^2/sec. (auth)

40039 INVERSE POLAROGRAPHY OF TECHNETIUM. Astheimer, L.; Schwochau, K. (Kernforschungsanlage, Juelich, Ger. Univ., Cologne). J. Electroanal. Chem., 14: 240-1(1967). (In German).

The inverse polarography of Tc was studied for its suitability for the analytical determination. In alkaline $KTcO_4$ solutions polarograms that can be easily evaluated are obtained at a precipitation potential of −1.0 V. In neutral solution the waves are only indicated, and they are completely absent in acid solution. A characteristic inverse polarogram of TcO_4^- in alkaline solution with point potentials at −0.33 and −0.20 V is given. There was linear dependence on the concentration for the wave at −0.33 V in the concentration range from 10^{-4} to 10^{-7}M Tc and for the wave at −0.20 V in the concentration range from 10^{-4} to 4×10^{-4}M Tc. (J.S.R.)

40040 X-RAY FLUORESCENCE ANALYSIS OF STRONTIUM IN BONE. Oliver, W. R. (Robert Gordon's Inst. of Tech., Aberdeen, Scotland). Lab. Pract., 17: 690; 718(June 1968).

A non-destructive method of estimating the strontium content of animal bone is described. The method of sample preparation ensures that results are reproducible. The results ob-

tained are comparable with those obtained by other methods. (auth) (UK)

40041 THE RAPID DISSOLUTION OF PLUTONIUM DIOXIDE BY A SODIUM PEROXIDE–SODIUM HYDROXIDE FUSION, FOLLOWED BY DETERMINATION OF THE PLUTONIUM CONTENT BY CONTROLLED-POTENTIAL COULOMETRY. Milner, G. W. C.; Crossley, D. (Atomic Energy Research Establishment, Harwell, Eng.). Analyst, 93: 429-32(July 1968).

The plutonium dioxide is brought into solution by fusion with a mixture of sodium peroxide and sodium hydroxide at 600°C for 15 minutes in an alumina crucible. The cold melt is leached with water, which is then acidified with sulphuric acid. The solution is heated for 15 minutes to decompose hydrogen peroxide and, after cooling, diluted to a suitable volume. The plutonium content of an aliquot containing about 4 mg of plutonium is determined by controlled-potential coulometry. A potential of +0.30 volt versus a S.C.E. is used for reduction of plutonium(III), and +0.70 volt versus a S.C.E. for the quantitative oxidation to the plutonium(IV) state. Mean recoveries on 100-mg amounts of plutonium dioxide ignited at 850°C were 99.95%, with a coefficient of variation of 0.11%. For the complete dissolution of samples previously ignited at higher temperatures (about 1600°C), an increase in the ratio of the weight of fusion mixture to sample is necessary. Mean recoveries on 50-mg amounts of plutonium dioxide ignited at 1600°C were 99.85%, with a coefficient of variation of 0.54%. (auth) (UK)

40042 DETECTION OF RARE EARTH IMPURITIES IN IONIC MATERIALS BY X-RAY-STIMULATED LUMINESCENCE. Shand, W. A. (Univ. of Aberdeen, Scotland). J. Mater. Sci., 3: 344-8(July 1968).

Application of x-ray-stimulated luminescence to the detection of trivalent rare earth impurities in ionic materials is discussed. Characteristic luminescent wavelengths allow identification of individual rare earths. The lower limit of impurity detectable in the case of fluorides was found to be about 0.01 ppM if no positive identification of the rare earth ion was required. This was increased to 1 ppM when positive identification of the specific impurity was required. The application of the technique to the assessment of single crystals and the appropriate starting material is discussed. (auth) (UK)

40043 DETERMINATION OF WATER CONTENT IN POROUS MATERIALS BY MEANS OF NUCLEAR RADIATION. Kleijn, H. R. (Reactor Inst., Delft, Netherlands). Atoomenergie Haar Toepass., 10: 148-53(June 1968). (In Dutch).

Fast neutrons from (α,n) sources are used to determine water contents in materials such as wood, coal, etc., if it amounts to 5% or more. A BF_3 detector is placed near the source in a large sample (about 50 or 100 l). Since it detects mainly thermal neutrons and since the moderation is caused mainly by H nuclei, the counting rate is a measure of the water content. Gamma radiation can also be used since water present in the material will cause a higher absorption than dry material. Relatively small samples are sufficient. Both methods have to be calibrated by conventional methods. Principles and technical procedures are discussed in detail. (J.J.t B.)

40044 APPLICATION OF X-RAY FLUORESCENCE SPECTROGRAPHY FOR THE ANALYSIS OF URANIUM IN THE URANIUM COMPOUNDS. Renaud, J.; Desson, P. Energ. Nucl. (Paris), 10: 93-100(Mar.-Apr. 1968). (In French).

The principle of x-ray fluorescence spectrography is outlined and a brief description is given of the measurement devices. The application of x-ray fluorescence analysis to the control of the operation of a plant for the processing of uranium ores is described. Use of x-ray fluorescence analysis in control of grinding of the ore, sulfuric attack of the ore, countercurrent washing of the solids, separation of uranium on ion-exchange resins, and precipitation of the uranium concentrates are outlined. Among the most practical applications are the determination of the uranium content of the solid products, determination of uranium after solid dilution of the uranium ores, and determination of uranium in solution. (J.S.R.)

40045 ANALYSIS OF COPPER AND SILVER IN COPPER ORES BY THE PHOTON-ACTIVATION METHOD. Pradzynski, Andrzej (Urzad Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej, Warsaw); Sulin, Weniamin W.; Witozenc, Henryk Cz. Nukleonika, 13: 581-90(1968). (In Polish).

A routine method for copper determination in copper ores, products of their processing, concentrates, and tailings was studied, and the parameters of photon activation analysis were determined. A betatron was used as the source of high energy bremsstrahlung photons. The precision of this method was found to be 3.8% for low Cu concentrations (in tailings), and 1.9% for medium Cu concentrations (in semiproducts). The possibility of determining silver in the presence of copper in the concentrate was also investigated. (auth)

40046 DETERMINATION OF ASH CONTENT IN BROWN COAL BY GAMMA–GAMMA LOGGING. Szymborski, Andrzej; Krupa, Jan (Przedsiebiorstwo Poszukiwan Geofizycznych, Warsaw). Nukleonika, 13: 561-80(1968). (In Polish).

The possibility of determining the ash content in brown coal by various well logging methods is analysed. It was found that it is not possible to determine the ash content by electric well logging methods due to great differences in the chemical composition of the ash. Neither is it possible to determine the ash content by gamma logging because of the great differences in the silty material content. Furthermore, the excessive humidity of brown coals renders the application of neutron–gamma logging impossible. The relation between the equivalent atomic number and the ash content was analyzed. Because of the great variations in the chemical ash composition the selective gamma–gamma logging is not convenient for ash content determination. The basic method which enables to determine the ash content is the formation density logging, since there is a relationship between the bulk density and the ash content. From the laboratory investigations and field research, which were carried out, it can be concluded that it is possible to determine the brown coal ash content with an accuracy of ±5%. (auth)

40047 RADIOMETRIC METHODS OF DETERMINING THE CONTENT OF MINERAL MATTER (ASH) IN COALS FROM UPPER SILESIA AND IN BROWN COALS FROM THE TUROW MINE. Burek, R.; Mirkowski, C.; Pawlak, J. (Glowny Instytut Gornictwa, Katowice, Poland). Nukleonika, 13: 535-45(1968). (In Polish).

The determination of ash content in coal by the x-ray absorption method and by the beta-particles backscattering method is described. The accuracy of the determination is analysed. (auth)

40048 DETERMINATION OF THE MAIN COMPONENTS IN ORES BY RADIOMETRIC METHODS. Dziunikowski, B. (Akademii Gorniczo-Hutniczej, Krakow). Nukleonika, 13: 361-9(1968). (In Polish).

A short review of the physical principles of several radiometric methods of analysis is given. The industrial analytical problems solved at the Institute of Nuclear Techniques of the Academy of Mining and Metallurgy in Cracow, using these physical methods are discussed. (auth)

40049 PURITY AND ANALYSIS OF LABELLED COMPOUNDS: REVIEW NO. 8. Catch, J. R. Amersham, Eng., Radiochemical Centre (UKAEA), 1968. 24p.

The following aspects are discussed: determination of radiochemical purity (including imperfect resolution in chromatography, and reverse isotope dilution analysis); effects of decay and decomposition; position or pattern of labelling; nonisotopic labelling; chemical purity; pharmaceutical purity; case histories; validity of analytical evidence; precautions taken at RCC; and conclusions. (UK)

40050 NEW CONCEPT OF AUTOMATED RADIOCHEMICAL ANALYSIS BASED ON SUBSTOICHIOMETRIC SEPARATION. Ruzicka, J.; Lamm, C. G. (Univ. of Demark, Lyngby). Talanta, 15: 689-97(July 1968).

Tracer methods, employed in radioisotope dilution, radiometric analysis, concentration dependent distribution, saturation analysis techniques, etc., are compared on a basis of radioactivity–mass balance relationships, and their automation is proposed. The requirements of a chemical separation, which is an integral part of these methods, are discussed. It is shown that automation, in addition to its obvious advantages, enables entirely new procedures to be developed, based on chemical separations which do not give reproducible results when performed normally. Simple commercially available apparatus was used to verify these concepts by determination of traces of mercury. As little as 0.005 ppM of Hg can be determined, the detection limit being about a tenth of this. In the range 2.4 to 0.03 ppM, 20 samples/hr can be analysed; for lower amounts the sampling rate is 10 samples/hr. (auth) (UK)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 40024, 40025, 40205, and 41046.

40051 (ANL-Trans-632) CHEMICAL PROPERTIES OF THE ELEMENT 104-KURCHATOVIUM. Zvara, I.; Chuburkov, Yu. T.;

Tsaletka, R.; Shalaevskii, M. R.; Zvarova, T. S.; Shilov, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report JINR-D7-3548. 11p. Dep. CFSTI.

An abstract of this paper was prepared from the original language and appeared as NSA 22: 140. (TSS)

40052 (KR-126, pp 101-19) TBP EXTRACTION SYSTEMS. FISSION PRODUCT CHEMISTRY IN RELATION TO TBP PROCESSES. Naylor, A. (United Kingdom Atomic Energy Authority, Sellafield, Eng.).

The chemistry of the fission products Ru, Nb, and Zr as related to the TBP extraction process for separation of U and/or Pu from irradiated fuels is considered from 3 aspects: their general solution chemistry, their process behavior and the effect of certain variables on decontamination values, and their specific distribution behavior in a countercurrent contactor related to the known data on identification of known species in process solutions. (B.L.M.)

40053 (LA-3951) ENTHALPIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). June 3, 1968. Contract W-7405-eng-36. 7p. Dep. CFSTI.

The relative partial molar heats of solution for selected solutes in liquid plutonium were calculated from solubility data from 700 to 1000°C by the equation, $R \ln N_i = \Delta S_f - \Delta\overline{H}_i^*/T$, where R is the gas constant, N_i is the mole fraction of solute i in a saturated solution at absolute temperature T, ΔS_f is the entropy of fusion of i, and $\Delta\overline{H}_i^*$ is the sum of the heat of fusion ΔH_f of i and the excess enthalpy of solution. The entropy of fusion for these solutes was taken as 2.3 eu. The calculated relative partial molar heats of solution ($\Delta\overline{H}_i^*$ in kcal/mole) are: tungsten, 22.0; tantalum, 16.6; niobium, 11.1; vanadium, 11.0; molybdenum, 10.3; chromium, 9.5; and thulium, 9.2. These heats of solution were correlated with solubility parameters by a constant k determined from the data, so that $\Delta\overline{H}_i^* = \Delta H_f + k\overline{V}_i\,(\delta_i - \delta_{Pu})^2$, where $\overline{V}_i$ is the molar volume of solute i and δ_i and δ_{Pu} are the cohesive factors. (auth)

40054 (NYO-2269-12) STUDIES IN SOLUTION AND NUCLEAR CHEMISTRY. Progress Report, October 1, 1967-September 30, 1968. Marinsky, Jacob A.; Clarke, George A. (State Univ. of New York, Buffalo. Dept. of Chemistry). July 1, 1968. Contract AT(30-1)-2269. 323p. Dep. CFSTI.

A report is given of research to elucidate the ion-exchange phenomenon; to study the solution chemistry of the alkali metals, the alkaline earths, and the transition elements in the presence of linear and crosslinked polyelectrolytes; and to extend theoretical development of a polyelectrolyte model for the knowledge interpretation of experimental results. Various ion-forms of Dowex-50 resin, its polyelectrolyte analog, polystyrene sulfonic acid, Amberlite IRC-50 resin, its linear polyelectrolyte analog, polymethacrylic acid, and poly-L-glutamic acid were and are being employed to facilitate these objectives. Investigation reported of solvent selectivity as well as ion-exchange selectivity of Linde-A zeolite in nonaqueous and mixed media is especially pertinent to the first objective listed. Ion exchange as well as polarographic and potentiometric techniques continue to be employed to accomplish the goals of this program. Spectral and osmotic studies proved extremely useful to the program as well. Additional insight with respect to the objectives of the program are expected to accrue from calorimetric and Mössbauer studies initiated. The progress made in the nuclear portion of the program that is concerned with studies of the independent fission yield of technetium is also reported. A terminal report of the relevant spectroscopic results of the Solution Laser phase of the research program is given together with recent results of theoretical studies of bonding, including that involving transition metal ions in a molecular orbital theory approximation. (auth)

40055 PART I. STEREOCHEMISTRY OF NORBORNYL DERIVATIVES. A NUCLEAR MAGNETIC RESONANCE STUDY. PART II. KINETIC ISOTOPIC STUDIES OF THE DEHYDROBROMINATION OF THE 2,3-DIBROMONORBORNANES. Subramanian, Pallatheri Manackal. Detroit, Wayne State Univ., 1964. 123p.

A series of 5,6-dihalo-2-norbornenes and 2,3-dihalonorbornanes were synthesized, and a systematic NMR study was undertaken. Careful spectral studies with these compounds and several of their stereospecifically deuterium labeled analogs, coupled with nuclear magnetic double resonance experiments afforded considerable information about the spin-spin interactions of the various protons. Significant observations were those of unequal coupling constants between the endo-cis and exo-cis protons, and the absence of any interaction between an endo proton(s) and the bridgehead proton(s). Unique, long-range couplings between endo-C-5,6- and anti-C-7-protons, vinyl and anti-C-7-protons, and the two bridgehead protons were found for the dihalonorbornenes. "Virtual coupling" was also detected with systems possessing strongly coupled, isochronous nuclei. Some information about the stereochemistry could be delineated from an investigation of the spectra of these compounds in aromatic and nonaromatic solvents. It was noticed that an exo-proton is usually shielded more than other protons in an aromatic solvent. Empirical correlations between chemical shifts and stereochemistry as well as electronegativity of the substituents(s) have been made. A careful kinetic analysis of the elimination of hydrogen bromide from endo-cis- and trans-2,3-dibromonorbornane using sodium t-amyloxide as the base, was carried out. The results from these experiments, coupled with values for the primary kinetic isotope effects obtained from their dideuterated analogs, confirmed a preferred concerted pathway and a favored cis elimination. Studies with 2-monodeuterotrans-2,3-dibromonorbornanes have unequivocally established the preferential exo proton abstraction by base. (Disser. Abstr.)

40056 ^{18}O EXCHANGE BETWEEN ENRICHED WATER AND PENTACYANONITROFERRATE(II) ION. West, Douglas X. (Central Michigan Univ., Mount Pleasant). J. Inorg. Nucl. Chem., 30: 1263-7(June 1968).

The rate of exchange of oxygen-18 between sodium pentacyanonitroferrate(II) and enriched water was studied. The effects on the rate of exchange caused by changes in concentration of the $Na_4Fe(CN)_5NO_2$, pH of the solution, ionic strength of the solution, and solution temperature were studied. A mechanism is proposed and a rate law is given. (auth) (UK)

40057 COEXISTENCE OF TETRAVALENT PLUTONIUM AND URANIUM IN AQUEOUS SOLUTION. Yanir, E. (Soreq Nuclear Research Centre, Yavneh, Israel); Givon, M.; Marcus, Y. J. Inorg. Nucl. Chem., 30: 1322-4(June 1968).

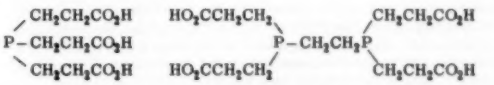
The formal potentials of the couples U(VI)-U(IV) and Pu(IV)-Pu(III) were measured in phosphoric acid solutions to determine if it was possible to bring the two formal potentials sufficiently near one another so that the two tetravalent species should coexist. From formal potential and spectral results it was concluded that tetravalent U and Pu should coexist in a solution of moderately concentrated phosphoric acid. (P.C.H.)

40058 ANALYSIS AND INTERPRETATION OF ELECTRON VIBRATING SPECTRA FOR URANYL COMPOUNDS. Sevchenko, A. N. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 69-85(1968). (In Russian).

A series of uranyl compounds was investigated and an analysis of their electron vibrating spectra made. Results of previous studies were annulled and a conclusion drawn concerning their incorrect interpretation. It is estimated that the fluorescence spectra change strongly, not only by introducing of an additional cation and diminishing of the crystalline water, but also by replacing the latter with heavy water. A conclusion is drawn that for a correct interpretation of the spectra the transitions between the energy levels in the crystal lattice should be taken into account. The kinds of symmetry of four electron levels in the case of D_{4h} symmetry of the uranyl group are given; the kind of symmetry of the excited level was not determined exactly. (auth)

40059 PHOSPHINE CARBOXYLIC ACID CHELATES. Wiedenheft, Charles John. Cleveland, Case Western Reserve Univ., 1967. 143p.

The chelating abilities of the following phosphine polycarboxylic acids are reported:



I II

A detailed study of the rare earth complexes of I was carried out to determine if participation of the f orbitals in bonding occurred. The chelates with the phosphine oxide tripropionic acid ligand, $O=P(CH_2CH_2-CO_2H)_3$, III, were also prepared. The relative stabilities of a number of representative transition metal chelates with I were determined by pH titrations. Although stability constants are not reported, it was observed that the Irving-Williams order of stability holds for the first-row transition metals. The enhanced stability of the second- and third-row transition metals relative to the first transition series is attributed to the importance of π-bonding. In forming coordination compounds, the phosphine tripropionic acid was quite similar to the analogous nitrogen-containing ligand, nitrilotriacetic acid. Thus, 1:2 complexes, $[ML_2]^{-4}$, and double salts of the type $M_2[ML_2]$ were readily formed. The solid compounds finally studied were of the form $Ba_2[ML_2]$. Spectral data, both infrared and electronic absorption, and magnetic moments are reported for these compounds, and from this information structures are suggested. All the transition

metal chelates appear to be octahedral. The results of chemical and spectral studies of the chelates with the phosphine ligand are discussed in terms of C_{2v} and D_{4h} symmetry; the phosphine oxide complexes have properties characteristic of formal O_h symmetry. The rare earth complexes of both I and III were prepared to determine if π-bonding might involve the f electrons. Both ligands formed 1 : 1 complexes with the rare earth metals; water also appears within the coordination sphere. Differential thermal analysis and thermal gravimetric analysis were used to determine the nature of the water in these complexes. The results indicate that the phosphine-rare earth complexes are 8-coordinate; several of the complexes with the phosphine oxide are 7-coordinate and others are 8-coordinate. As expected, the relative stabilities of these chelates increase with atomic number. The visible spectrum of the rare earth chelates and the magnetic moments indicate no participation of the f electrons in π−bonding. Finally, the complexes with Th^{4+} and UO_2^{2+} and I were prepared. The compounds isolated analyze for $[Th(OH)(PC_9H_{12}O_6)] \cdot 5H_2O$ and $Na[UO_2(PC_9H_{12}O_6)] \cdot H_2O$. (Disser. Abstr.)

40060 ORGANIC MOLECULES FOR THE IR ANALYSIS OF ^{15}N AND ^{18}O. Schmidt, H.-L.; Schmelz, E.; Rohns, G. (Univ. des Saarlandes, Saarbruecken, Ger.). Isotopenpraxis, 4: 133-6(Apr. 1968). (In German).

Nitrogen or oxygen from organic compounds, after being converted to NH_3 or H_2O, can be covalently bound to iodine, phosphorus, carbon, or hydrogen. The so formed products should be suitable for ir analysis. As a primary presumption for such an analysis, conditions for binding quantitatively NH_3 or H_2O in the millimole range by different reagents were investigated: band shifts in the spectra of labeled products are given. Satisfying results were obtained with di-p-tolyl-carbodiimide and with 2,4-dinitrofluorobenzene. By means of the ir spectra of di-p-tolyl-guanidine, the reaction product of di-p-tolyl-carbodiimide and NH_3, the possibility of using band shifts for the ir spectrophotometric isotope analysis is demonstrated. (auth)

40061 RATE OF REACTION OF NITROUS ACID WITH HYDRAZINE AND WITH SULPHAMIC ACID. ITS APPLICATION TO NITROUS ACID CONTROL IN TWO-PHASE INDUSTRIAL SYSTEMS. Biddle, P.; Miles, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 30: 1291-7(June 1968).

The rate of reaction of nitrous acid with excess sulphamic acid or hydrazine was measured in nitric acid media by a continuous flow technique. The rates were approximately first order in nitrous acid and reactant, and the dependence on hydrogen ion concentration was about first-order for sulphamic acid, and second-order for hydrazine. A new absorption band was found at 415 mμ in reacting solutions of nitrous and sulphamic acids. The rates obtained were used to estimate the minimum concentrations of these reagents required to control the oxidation of Pu(III) in uranium−plutonium separation processes. (auth) (UK)

40062 THERMODYNAMIC AND KINETIC PROPERTIES OF SOME ALKALI AND ALKALINE EARTH CHLOROZIRCONATE AND CHLOROHAFNATE COMPOUNDS. Dutrizac, John Edward. Toronto, Univ. of Toronto, 1967.

The stoichiometric compounds, Li_2ZrCl_6, Li_2HfCl_6, Rb_2ZrCl_6, $BaZrCl_6$, and $SrZrCl_6$, were prepared by the direct reaction of gaseous $ZrCl_4$ or $HfCl_4$ with the appropriate chloride salt in a fine degree of subdivision. Properties such as colour, density, and melting points were determined for these compounds. The binary equilibrium phase diagrams for the systems $LiCl-Li_2ZrCl_6$, $LiCl-Li_2HfCl_6$ and $Li_2ZrCl_6-Li_2HfCl_6$ were determined by cooling curve methods. Cryoscopic calculations were performed on the various phase diagrams and the results interpreted in terms of melt structure. The vapor pressures over the above pure compounds, as well as the reaction pressures across the phase diagrams $LiCl-Li_2ZrCl_6$ and $LiCl-Li_2HfCl_6$, were measured using an isoteniscope with molten Sn. The pressure data were used to calculate various thermodynamic functions for these salts. A comprehensive theory relating vapour pressures in different regions of a simple eutectic-type phase diagram to the partial molar properties of the components has been advanced and discussed. An adiabatic drop calorimeter was designed and constructed; this instrument was used to determine the enthalpy functions of Li_2ZrCl_6, Li_2HfCl_6, Na_2ZrCl_6, and K_2ZrCl_6, as well as the heats of the fusion and prefusion transformations in these compounds. The kinetics of formation of Na_2ZrCl_6 from NaCl single crystals and $ZrCl_4$ vapour were investigated. Analyses of these results showed the reaction to be diffusion controlled with $ZrCl_4$ being the diffusing species. The apparent energy of activation was determined from the variation of the rate constant with temperature. A preliminary investigation was made into the possibility of separating $HfCl_4$ from $ZrCl_4$ by selective reaction of these gases with an alkali chloride salt. The separation efficiency was determined as functions of salt composition, tetrachloride to salt ratio, and the number of separation steps. Continuous separation was also attempted but found to be less effective than simple batch operations. This process appears to be commercially attractive as a method of separating Hf from Zn. (Disser. Abstr.)

40063 PREPARATION AND PROPERTIES OF SOME COMPLEX COMPOUNDS OF URANIUM HALIDES. Hayton, B. London, Birkbeck Coll., 1968. 215p.

The coordination chemistry of uranium in its different valency states is reviewed. The reactions of uranium tetrachloride and uranyl chloride with various organic ligands were investigated. Addition compounds were obtained with amines, esters, alcohols, and phosphine oxides, under anhydrous conditions. Hexachlorouranate(IV), tetrachlorodihydroxyuranate(IV), and tetrachlorodioxouranate(VI) salts, were prepared. Addition compounds of triphenylphosphine could not be made. Volumetric analysis methods were developed for the determination of uranium by ceric sulphate in the presence of nitric acid, and the determination of tervalent phosphorus by Karl Fischer reagent. Infrared absorption spectra, ultraviolet reflectance spectra, magnetic susceptibilities, and electrical conductivities in solution, were recorded, and are discussed in terms of structure and bonding in the uranium compounds. (auth) (UK)

40064 METAL CHELATES OF URANIUM(VI) AND THORIUM-(IV) WITH DISODIUM-1:8-DIHYDROXYNAPHTHALENE-3:6-DISULPHONATE: A POTENTIOMETRIC STUDY. Banerjee, Amitav; Dey, Arun K. (Univ. of Allahabad, India). J. Inorg. Nucl. Chem., 30: 995-1003(May 1968).

The Calvin−Bjerrum pH-titration technique, as used by Irving and Rossotti (J. Chem. Soc. 2904(1954) and 3397(1953)), was applied to determine the stepwise protonation constants of the ligand and the stepwise formation constants of the chelates. The changes of color during titration were related to the formation of different complex species in solution. The experiments were carried out with a constant ionic medium of 0.1 M $NaClO_4$ and at a constant temperature of 25°C. (auth)

40065 LATTICE CONSTANTS OF AmO_2F_2. Keenan, T. K. (Los Alamos Scientific Lab., N. Mex.). Inorg. Nucl. Chem. Lett., 4: 381-4(July 1968).

Americyl difluoride was synthesized and found to be hexagonal (rhombohedral) (a_0 = 4.136 Å, c_0 = 15.85 Å), with space group R $\bar{3}$ m, three molecules per hexagonal unit cell. The product was isostructural with other hexavalent actinide difluorides. (UK)

40066 STERIC ISOTOPE EFFECTS. II. THE DEUTERIUM ISOTOPE EFFECT IN THE RACEMIZATION OF (+)-2,2'-DIBROMO-4,4'-DICARBOXYBIPHENYL-5,5'-d_2. Carter, Robert E.; Junggren, Elisabet (Univ. of Goteborg. Chalmers Inst. of Tech., Goteborg). Acta Chem. Scand., 22: 503-8(1968).

The compound (+)-2,2'-dibromo-4,4'-dicarboxybiphenyl-5-5'-d_2 was synthesized and its rate of racemization compared with that of the corresponding protium compound. The kinetic isotope effect ratio, k_D/k_H, was found to be 1.02 ± 0.02. (auth) (Denmark)

40067 CRYSTAL AND MOLECULAR STRUCTURE OF SODIUM URANYL TRIPEROXIDE. Alcock, N. W. (Univ. of Warwick, Coventry, Eng.). J. Chem. Soc., A, No. 7, 1588-94(1968).

The crystal structure of sodium uranyl triperoxide nonahydrate, $Na_4[UO_2(O_2)_3]$, $9H_2O$, was determined by single-crystal x-ray diffraction, using the heavy-atom method. The main structural feature is the uranyl triperoxide anion consisting of three co-planar peroxide groups equatorially surrounding a linear uranyl group, in approximately D_{3h} symmetry. The mean U−O (uranyl) distance is 1.86, the U−O (peroxide) is 2.28, and the peroxide O−O 1.5 Å. The water molecules are coordinated in octahedra around the sodium atoms. The crystals are monoclinic, space group $P2_1/c$, a = 6.413, b = 17.292, c = 14.186 Å, β = 98.52°. The ir and Raman spectra of this and some related compounds are reported, with tentative assignments. (auth) (UK)

40068 DYNAMICS OF ION−MOLECULE REACTIONS. Mahan, Bruce H. (Univ. of California, Berkeley). Accounts Chem. Res., 1: 217-24(July 1968).

In recent experiments the energy and angular distributions of the products of ion-molecule reactions have been determined. Analysis of these data shows that, for $N_2^+ + D_2 \rightarrow N_2D^+ + D$ and other related hydrogen-abstraction reactions, most of the products are formed with very high internal excitation by grazing collisions. Very large isotope effects are found and can be understood in terms of product internal excitation and stability with respect to dissociation. In studies of nonreactive but inelastic ion-molecule collisions, clear evidence of electronic and vibrational excitation processes has been found. These data begin to

give us a picture of the detailed dynamics of chemical reactions and inelastic collisions. (auth)

40069 ISOLATION AND CHARACTERIZATION OF URANYL NITRATE MONOHYDRATE. Chottard, Genevieve (Faculte des Sciences, Paris). Compt. Rend., Ser. C, 267: 147-8(July 8, 1968). (In French).

Study of the thermal decomposition of uranyl nitrate hexahydrate led to the isolation of a compound with the formula $UO_2(NO_3)_2 \cdot H_2O$. Its powder diagram, its infrared absorption spectra, and also several data on its conditions of formation and its stability are reported. (tr-auth)

40070 THE INFLUENCE OF TUNNELING ON THE RELATION BETWEEN TRITIUM AND DEUTERIUM ISOTOPE EFFECTS. THE EXCHANGE OF 2-NITROPROPANE-2-t. Lewis, Edward S.; Robinson, John K. (Rice Univ., Houston, Tex. Oxford Univ.). J. Amer. Chem. Soc., 90: 4337-44(July 31, 1968).

Tritium and deuterium isotope effects can be related by an equation derived by Swain and coworkers, without consideration of tunneling. The influence of tunneling on this relationship is explored, with consideration of deviations predicted by some theoretical models. It is shown that conspicuous deviation will occur only under some rather restricted conditions, even when tunneling is quite extensive. Three examples in which tunneling was believed to be important were subjected to this test. The oxidation of 1-phenyl-2,2,2-trifluoroethanol by alkaline permanganate gave a tritium isotope effect, $k_H/k_T = 57.1$, in close agreement with the value 55.5 calculated with the Swain equation from the previously measured deuterium isotope effect. A very large isotope effect, $k_H/k_T = 82.9$, was calculated from the deuterium isotope effect for the proton transfer from 2-nitropropane to 2,4,6-trimethylpyridine, and the experimental value, $k_H/k_T = 79.1$, was nearly as large. The oxidation of leucocrystal violet by chloranil gave a calculated tritium isotope effect, $k_H/k_T = 27.3$, significantly greater than that found experimentally, $k_H/k_T = 20.3$, and the discrepancy is reasonably concordant with that expected from the strong temperature dependence of the deuterium isotope effect. The rate of ionization of 2-nitropropane-2-t by 2,4,6-trimethylpyridine measured by exchange was less than that measured by iodination, unless allowance is made for the significantly slow exchange of the pyridinium ion with the aqueous tert-butyl alcohol solvent. (auth)

40071 SOLVOLYSIS MECHANISMS. A KINETIC STUDY OF THE HYDROLYSIS AND IMIDAZOLE-CATALYZED HYDROLYSIS OF p-METHYL-, p-CHLORO-, AND p-NITROBENZOYLIMIDAZOLE IN H_2O AND OF p-NITROBENZOYLIMIDAZOLE IN D_2O. Klinman, Judith Pollock; Thornton, Edward R. (Univ. of Pennsylvania, Philadelphia). J. Amer. Chem. Soc., 90: 4390-4 (July 31, 1968).

The kinetics of the hydrolysis of p-methyl-, p-chloro-, and p-nitrobenzoylimidazole in H_2O–imidazole buffer solutions and of p-nitrobenzoylimidazole in D_2O–imidazole buffer solutions was studied at 2507 ± 0.05°C and μ = 0.0400 ± 0.0006 M. The rates of hydrolysis were first order in acylimidazole concentration. A linear dependence of the observed rate constants on the imidazole free base concentration was demonstrated for each compound at each pL (L = H or D), giving intercept k_{L_2O} and slope k_{Im_T}/Im. The pL dependence of k_{L_2O} in the pL regions studied (pH 6.9 to 7.8, pD 7.5 to 8.1) is given by $k_{L_2O} = k_1 + k_2[LO^-]$. The isotope effects observed for k_1 and k_2 in the reaction of p-nitrobenzoylimidazole were $k_1(H_2O)/k_1(D_2O) = 5.57 \pm 0.51$; $k_2(D_2O)/k_2(H_2O) = 1.47 \pm 0.16$. From Hammett plots for k_1 and k_2, ρ = 1.41 and 1.48, respectively. The imidazole catalysis appears to be pL dependent, although experimental scatter and the limited pL range presently available preclude precise analysis. The most consistent treatment of the data includes three terms, proportional to imidazole, to imidazolium, and to the product of imidazole and lyoxide concentrations. Estimates of these three imidazole-dependent terms were not made from k_{Im_T}/Im, but by the (statistically less biased) direct fit of experimentally observed rate constants to the complete, five-term expression including k_1, k_2, and the three imidazole-dependent terms, using a least-squares computer program. In studies of imidazole catalysis, it seems unsafe to assume dependence entirely on free imidazole even in the region of neutrality, unless measurements are made at several pL values. (auth)

40072 DEUTERIUM ISOTOPE EFFECTS IN THE PHOTOCHEMISTRY OF AN AZETIDINE KETONE. Padwa, Albert; Gruber, Robert (State Univ. of New York, Buffalo). J. Amer. Chem. Soc., 90: 4456-8(July 31, 1968).

The mechanism of the photorearrangement of trans-1-tert-butyl-2-phenyl-3-benzoylazetidine, that involves expansion of the four-member nitrogen ring, was studied. Results of deuterium-labeled experiments provided evidence for a 1,3-diradical intermediate. The replacement of hydrogen by deuterium enhanced the amount of ring closure at that position. (D.H.M.)

40073 STRUCTURAL CHEMISTRY IN THE NUCLEAR AGE. Hamilton, Walter C. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Educ., 45: 296-303(May 1968).

The techniques of structural chemistry directly affected by nuclear technology are considered. Study of the solid state by diffraction and scattering techniques is described. Moessbauer spectroscopy, the impact of instrumentation on structural chemistry, magnetism, light atom–heavy atom studies, thermal parameters and electron density, biological structures, inelastic scattering, and structure of liquids are discussed. (M.C.G.)

40074 STRUCTURE OF A DINUCLEAR HYDROXO COMPLEX OF THORIUM. Johansson, Georg (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 22: 389-98(1968).

A crystal structure determination of $Th_3(OH)_3(NO_3)_6(H_2O)_6$ based on three-dimensional x-ray data showed that the crystals contain discrete dinuclear complexes $Th_2(OH)_2(NO_3)_6(H_2O)_4$. The thorium atoms within a complex are joined by a double hydroxo bridge, with a Th–Th distance of 3.98$_3$ Å. Three nitrate groups, acting as bidentate ligands, three water molecules, and two hydroxo groups are coordinated to each Th atom, which results in a coordination number of 11 for thorium. (auth) (Denmark)

40075 KINETIC ISOTOPE EFFECTS IN THE CATALYTIC SYNTHESIS OF AMMONIA. Logan, S. R.; Philp, J. (Univ. of Strathclyde, Glasgow). J. Catal., 11: 1-6(May 1968).

A reanalysis of the data of Ozaki, Taylor, and Boudart on the H/D isotope effect in ammonia synthesis does not support their conclusion that the surface is covered chiefly by NH radicals. The evidence is shown to be more consistent with the presence of N atoms on the surface combined with the action of a H/D kinetic isotope effect in the dissociative adsorption of nitrogen. The magnitude of this enhancement factor, about 3.8 at room temperature, is that to be expected for the participation of an adsorbed H atom in the slow step of the dissociative chemisorption of nitrogen molecules. (auth)

40076 VIBRATIONAL SPECTRA AND STRUCTURE OF ORGANOGERMANES. III. $C_6H_5GeBr_3$ AND $C_6D_5GeBr_3$. Durig, J. R.; Gibson, B. M.; Sink, C. W. (Univ. of South Carolina, Columbia). J. Mol. Struct., 2: No. 1, 1-17(June 1968).

The ir spectra of liquid phenyltribromogermane and pentadeuterophenyltribromogermane were recorded from 4000 to 33 cm^{-1}. The corresponding Raman spectra of the liquids were also recorded and depolarization values measured. The phenyl vibrations were assigned by assuming C_{2v} symmetry for ring atoms. The vibrations of the $GeBr_3$ moiety were assigned by assuming "local" C_{3v} symmetry for this group. All the spectra were interpreted in detail, and the 39 fundamental vibrations were assigned based on previous assignments of benzene and monosubstituted benzenes as well as the corresponding deuterated molecules along with the expected band positions and the depolarization values. The assignments for the two molecules are shown to be consistent by means of the Teller–Redlich product rule. (auth)

40077 LOW-FREQUENCY VIBRATIONS OF MOLECULAR CRYSTALS. IV. BORIC ACID. Durig, J. R.; Green, W. H.; Marston, A. L. (Univ. of South Carolina, Columbia). J. Mol. Struct., 2: No. 1, 19-37(June 1968).

Far ir spectra of $B(OH)_3$, $B(OD)_3$, and $^{10}B(OH)_3$ were measured from 500 to 33 cm^{-1} at room temperature and $^{10}B(OH)_3$ at −170°C. Raman spectra were recorded with 4358 Å mercury arc and 6328 Å helium–neon laser excitation. Assignments are made for internal and lattice vibrations in terms of layer and crystallographic unit cell models. The O–H torsional frequency was observed near 800 cm^{-1}, and the two-fold barrier to internal rotation around the H–O–B bond was calculated to be 23 kcal/mole. (auth)

40078 STRUCTURE OF THE HYDROLYSIS PRODUCTS OF THORIUM. Johansson, Georg (Royal Inst. of Tech., Stockholm). Acta Chem. Scan., 22: 399-409(1968).

An x-ray investigation was made of solutions prepared by dissolving aqueous thorium oxide in thorium nitrate solutions. The variation of the scattering curves with the hydroxyl number at a total constant thorium concentration = 2 M was measured. The coordination number found for thorium in solution is close to the values found in crystal structures. The nitrate group is coordinated to thorium as a bidentate ligand. A dominating dinuclear complex is consistent with the data for low hydroxyl numbers but for more than about 2 OH per Th the average nuclearity is four or larger. The shortest distance between the thorium atoms in the polynuclear hydrolysis products is 3.94 Å, which is close to values found in basic thorium salts. Some structural models consistent with the scattering data are discussed. (auth) (Denmark)

40079 MOLECULAR STRUCTURE AND DEUTERIUM EXCHANGE IN MONOLAYERS OF SYNTHETIC POLYPEPTIDES.

Malcolm, B. R. (Univ. of Edinburgh). Proc. Roy. Soc. (London) Ser. A, 305: 363-85(July 1968).

An investigation was made of the structure and properties of synthetic polypeptide monolayers spread at the air/water interface. Two series of high molecular weight polymers were examined, esters of polyglutamic acid and polymers with hydrocarbon side-chains. The structure was investigated by measurement of the force/area relations and surface potentials with a Langmuir trough, and by measurement of the exchange rates of peptide deuterium. These direct methods were supplemented by infrared spectroscopy and electron diffraction observations on collapsed films removed from the surface. It was found that in all cases the properties of the monolayer were consistent with a structure consisting of condensed ordered arrays of α-helices. The collapse of a monolayer to form a bilayer causes either a plateau or an inflexion in the force/area curve. From the pressure required to form the bilayer and the work of adhesion between the polymer and water, obtained from Young's equation, the free energy of the polymer/vapor interface was calculated. The deuterium exchange measurements showed that exchange can take place in an intact α-helix, and how the exchange rate is influenced by the accessibility of the peptide group to water, the pH of the substrate, and the hydrophobic nature of the side chain; the conclusions are important in the interpretation of deuterium exchange in proteins. (auth) (UK)

40080 OSCILLOGRAPHIC STUDIES ON LANTHANIDES IN DIMETHYLSULPHOXIDE AND DIMETHYLFORMAMIDE. Gritzner, G.; Gutmann, V.; Schmid, R. (Technische Hochschule, Vienna). Electrochim. Acta, 13: 919-24(Apr. 1968). (In German).

Oscillographic polarography was applied to solutions of lanthanides in dimethylsulphoxide and dimethylformamide. The oscillopolarographic behavior of the lanthanides was compared with the results of dc polarography. Various types of electrodes were studied. Potassium and rubidium ions, as well as bisdiphenylchromium(I)iodide, served as reference elements. (auth) (UK)

40081 STUDIES ON URANYL COMPLEXES. III. URANYL COMPLEXES OF EDTA. Frausto da Silva, J. J. R.; Simoes, M. Lourdes Sadler (Instituto Superior Tecnico, Lisbon). Talanta, 15: 609-22(July 1968).

The uranyl complexes of EDTA were studied by potentiometry; stability constants of the 1:1 and 2:1 (metal to ligand) chelates were determined, as well as the respective hydrolysis and polymerization constants. Possible structures for these species are discussed. To account for the abnormally high stability of $UO_2(H_2O)HL^-$, hydrogen bonding between a protonated nitrogen atom of the ligand and one oxygen atom of UO_2^{2+} is suggested. (auth) (UK)

40082 SECONDARY ISOTOPE EFFECTS FOR SOLVOLYSES LEADING TO CLASSICAL NORBORNYL CATIONS. Schaefer, John P.; Foster, James P.; Dagani, Michael J.; Honig, Linda M. (Univ. of Arizona, Tucson). J. Amer. Chem. Soc., 90: 4497-8 (July 31, 1968).

The secondary isotope effects for the solvolysis of the exo- and endo-p-nitrobenzoates of 2-phenylnorbornan-2-ol were measured. The rate constants of the solvolysis are tabulated at 62.5 and 39.5°C. Results show that the magnitude of the secondary isotopes effects is not a property of the geometry of the exiphile but is rather a reflection of the electronic nature of the transition state that leads to the cation. It was concluded that results support a previous suggestion that the transition states for the solvolysis of simple exo-norbornyl compounds are nonclassical. (D.H.M.)

40083 CITRIC COMPLEXES OF PENTAVALENT PROTACTINIUM. Guillaumont, Robert (Laboratoire d'Arcueil, Val-de Marne, France). Bull. Soc. Chim. Fr., No. 5, 1956-61(May 1968). (In French).

In aqueous citric mediums of ionic strength 3, ($10^{-3} < [H^+] < 3\underline{M}$, $[H_3Cit] \leq 1\underline{M}$) pentavalent protactinium is engaged in eight monomeric hydroxocomplexes with one or two citrate groups for one atom of element. Their charge varies from 1 to −2. The equilibrium constants of these complexes were calculated as a function of the concentration of $PaOOH^{2+}$. Results were obtained by solvent extraction of $^{233}Pa(V)$ in the state of chelates in benzene solutions of thenoyltrifluoroacetone. (auth)

40084 PREPARATION OF CRYSTALLIZED POLYURANATES BY ALKALINE TREATMENTS OF SCHOEPITE UO_3, 2 H_2O. Wey, Raymond; Lauffenburger, Ivan; Saehr, Daniel (Ecole Superieure de Chimie, Mulhouse, France). Bull. Soc. Chim. Fr., No. 5, 1874-9(May 1968). (In French).

The solubility of schoepite UO_3, 2 H_2O in sodium carbonate solutions for different values of pH was studied. The treatment of schoepite by sodium hydroxide leads to some new compounds that are characterized by specific x-ray diffraction patterns. The Na_2O content of these products increased as the concentration of the alkaline solution increased, and reached a molar ratio UO_3/Na_2O of about 2.5. At the same time the solubility of these compounds in a sodium carbonate solution (pH = 9.6) decreased. The usual uranates and their hydrolysis products have about the same solubility as schoepite. (auth)

40085 THE HYDROGEN ISOTOPE EFFECT IN POTASSIUM HYDROSELENITE SINGLE CRYSTALS. THE PHASE TRANSITION AND DIELECTRIC ANOMALY IN $KD_3(SeO_3)_2$. Ivanov, N. R.; Shuvalov, L. A.; Gordeeva, N. V. (Crystallography Inst., Moscow). Sov. Phys.-Cryst. (Engl. Transl.), 13: 145-7(July-Aug. 1968).

Translated from Kristallografiya, 13: 177-9(Jan-Feb. 1968).

The synthesis, growth, and properties of $KD_3(SeO_3)_2$ are discussed. Studies indicated that the phase transitions are second order (the temperature dependences of all of the properties investigated were continuous at the transition temperature) and are accompanied by a change in the point group symmetry mmm → 1. (M.C.G.)

40086 X-RAY DIFFRACTION STUDY OF THE RHOMBIC PHASE OF HYDRATED URANIUM TETRAFLUORIDE AND ITS DEHYDRATION PRODUCTS. Zadneprovskii, G. M.; Gagarinskii, Yu. V.; Polishchuk, S. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Sov. Phys.-Cryst. (Engl. Transl.), 13: 48-51 (July-Aug. 1968).

Translated from Kristallografiya, 13: 63-7(Jan.-Feb. 1968).

The rhombic phase of $UF_4 \cdot 2.5H_2O$ and its dehydration products were studied by x-ray diffraction in vacuum. It was verified that this crystal hydrate constituted a compound of specific composition; its dissociation in vacuum yielded an x-ray amorphous phase, $UF_4 \cdot 0.5H_2O$ with a higher density (5.89 g/cm^3). The original substance and its dissociation product formed pseudo-crystals consisting of blocks of these two phases, retaining their previous habit. On further dehydration of $UF_4 \cdot 0.5H_2O$ the substance remained x-ray amorphous and in the anhydrous state constituted a metastable form of UF_4. (auth)

40087 THERMAL DIFFUSIVITY OF UN FROM 20° TO 1,000°C BY LASER PULSE METHOD. Nasu, Shoichi; Kikuchi, Takeo (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 5: 318-19(June 1968).

Some results obtained for the thermal diffusivity and heat capacity of uranium mononitride, together with calculated thermal conductivity values based on the measured data are reported in graphic form. The thermal diffusivity increased slightly from room temperature to 1,000°C. The thermal conductivities obtained from the product of diffusivity, heat capacity, and density are compared with previously published values. (D.H.M.)

40088 OXIDATION OF URANYL CHLORIDE. Kanellakopulos, B.; Parthey, H. (Nuclear Research Centre, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 30: 1209-13(June 1968).

The oxidation of uranyl chloride was investigated by thermoanalytical and x-ray diffraction methods. UO_2Cl reacts with oxygen according to: $3UO_2Cl_2 + O_2 \rightarrow U_3O_8 + 3Cl_2$. The surface reaction controls the rate. The activation energy and the frequency factor of the reaction were calculated. (auth) (UK)

40089 REACTION OF URANIUM OXIDES WITH ALKALI HALIDES. Allpress, J. G.; Anderson, J. S.; Hambly, A. N. (Univ. of Melbourne). J. Inorg. Nucl. Chem., 30: 1195-1208 (June 1968).

Reactions of the oxides UO_3 and U_3O_8 with excess alkali halides MX, particularly KCl, RbCl, and CsCl, were studied using techniques of ir spectroscopy and x-ray diffraction. The final product of these reactions is always the diuranate $M_2U_2O_7$, but several intermediate phases were detected and identified. These phases have the compositions $M_xUO_3Cl_x$ ($x \sim 0.8$) and $M_4U_5O_{16}Cl_2$. Some of the properties of these compounds are described, and the mechanism of the reaction is discussed. (auth) (UK)

40090 URANIUM–URANIUM MONOPHOSPHIDE PHASE EQUILIBRIA. Benz, Robert; Ward, C. H. (Los Alamos Scientific Lab., N. Mex.). J. Inorg. Nucl. Chem., 30: 1187-93(June 1968).

The U–UP phase diagram was deduced from x-ray, metallographic, and thermal analyses. The U–UP eutectic occurs at 1131 ± 5°C, with the eutectic composition near pure U. No solubility of U in the UP phase was detected metallographically, from which the P:U ratio of U-saturated UP was estimated to be not less than 0.997. The highest melting point observed for UP was 2850°C. From analyses of the melted product, the P:U ratio at the UP congruent melting point was estimated as 1.00. (auth) (UK)

40091 DISPROPORTIONATION AND ECE MECHANISMS. II. REDUCTION OF THE URANYL CATION IN PERCHLORIC ACID. Mastragostino, M.; Saveant, J. M. (Ecole Normale Superieure, Paris). Electrochim. Acta, 13: 751-62(Apr. 1968).

The reduction of the uranyl cation at a mercury electrode in strongly acidic perchlorate media was studied using linear sweep voltammetry. The experimental results support the assumption of coupled ECE-disproportionation mechanisms. The ECE (electrochemical-chemical-electrochemical) behavior is favored by an increase of sweep rate and by a decrease of uranyl concentration. Opposite variations of the same factors increase the kinetic influence of the U(V) disproportionation reaction. The interference of the ECE mechanism is more readily detectable using linear sweep voltammetry rather than polarography. Only in the strongest acid solution does the ECE mechanism proceed without any detectable interference of disproportionation. Kinetic characterization of the ECE reaction path is attainable under these conditions. The disproportionation rate constant was determined for all the media considered. (auth) (UK)

40092 METHYL RADICAL REACTIONS WITH ETHANOL AND DEUTERATED ETHANOLS. Gray, Peter; Herod, A. A. (Univ. of Leeds, Eng.). Trans. Faraday Soc., 64: 1568-76 (June 1968).

The rates of hydrogen abstraction by methyl radicals from the three different sites in ethanol were measured by studying three isotopically different ethanols: CH_3CH_2OH, CH_3CD_2OH and CH_3CH_2OD. Photolysis of acetone and acetone-d_6 over the temperature range 130 to 250°C was used as the source of methyl radicals, and velocity constants were obtained for five elementary reactions. It was found that abstraction took place from all three sites. The methylene group is the most reactive site in the molecule, and the methyl group the least. At 150°C, 75% of the hydrogen came from CH_2, 20% from OH and about 5% from CH_3. Arrhenius parameters for methyl radical attack based on Shepp's rate-constant for methyl radical combination are given. Isotope effects were determined for the methylene and hydroxyl groups; at 150°C, (k_{CH_2}/k_{CD_2}) was 6.3 and (k_{OH}/k_{OD}) was 3.2. The activation energy difference $E_{CD_2} - E_{CH_2}$ was somewhat greater than would be expected from the zero-point-energy difference, and tunnelling may contribute to this. A hydrogen exchange reaction between acetone and the hydroxyl group of ethanol was found to occur. Its importance is to limit the validity of abstraction studies to isotopically compatible systems. Such pairs were studied. (auth) (UK)

40093 ARSENAZO III AND ITS ANALOGUES. V. COMPLEX FORMATION OF NIOBIUM WITH o,o'-DIHYDROXYAZO COMPOUNDS. Alimarin, I. P.; Savvin, S. B.; Okhanova, L. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Talanta, 15: 601-8(July 1968).

A new group of reagents, the 2,7-bisazo derivatives of chromotropic acid, was synthesized and the reaction of these compounds with niobium studied. Reaction with niobium occurs in strongly acidic medium (1 to 3N) and is characterized by high sensitivity ($\epsilon = 30$ to 50×10^3). The functional grouping responsible for the reaction was shown to be the o,o'-dihydroxyazo group. The analytical usefulness of the reagents is determined by the presence of the electron-withdrawing substituents and the nature of the diazo coupling component. Niobium reacts in partially hydrolysed form with these reagents, to give 1:1 complexes. (auth) (UK)

40094 ELEMENTARY PROCESSES IN THE REACTION OF OXYGEN ELECTRODE IN SOLID OXIDE ELECTROLYTES AT HIGH TEMPERATURE. Kleitz, M.; Besson, J.; Deportes, C. (Faculte des Sciences, Grenoble, France). Rev. Energ. Primaire, 2: 35-41(1966). (In French).

The contact between graphite and refractory oxide (stabilized zirconia) in the presence of pure or dilute oxygen, under various pressures, was investigated. The first results show, among others, that the oxygen electrode reaction proceeds from a gas adsorption process and an oxygen diffusion process in the adsorbed phase. The existence of an electrode reaction called electrolysis of the zirconia is also described. (auth)

40095 THERMOPHYSICAL PROPERTIES OF CARBON DIOXIDE. Gaunt, D. S. (ed.). London, Collet's, 1968. 477p. Translated from the Russian.

Topics covered include: density; phase equilibrium; enthalpy; specific heats; equation of state; thermodynamic functions in the ideal gaseous state; tables of thermodynamic properties; viscosity, self-diffusion and thermal conductivity coefficients, Prandtl number at atmospheric pressure; pressure-dependence of viscosity; and pressure dependence of thermal conductivity. (UK)

40096 INVESTIGATIONS ON THE DISTRIBUTION OF RADIUM BETWEEN THE SOLID AND THE LIQUID PHASE IN THE PROCESS OF "SYNCHRONIZED" PRECIPITATION. PART III. BARIUM–RADIUM OXALATE AND BARIUM–RADIUM IODATE. Przytycka, Roza (Inst. of Nuclear Research, Warsaw). Nukleonika, 13: 691-8(1968).

The "synchronized" precipitation technique was applied to investigate the distribution of radium in mixed crystals of barium–radium oxalate and barium–radium iodate. The behavior of three distribution coefficients and the influence of the quantity of precipitated barium and pH of solution on their values were examined. (auth)

40097 ISOTOPIC EXCHANGE BETWEEN GASEOUS DEUTERIUM AND AQUEOUS ALKALINE SOLUTION. Lin, Chao-feang (Hokkaido Univ., Sapporo). J. Res. Inst. Catal., Hokkaido Univ., 15: 218-27(1967).

The isotopic exchange reaction between gaseous deuterium and aqueous potassium hydroxide solution was investigated at various concentrations of hydroxyl ion ranging from 0.01 to 1 gram ion per liter and at 100°C. The reaction was confirmed to be homogeneous, with the rate proportional to the partial pressure of deuterium gas and to the concentration of hydroxyl ion. "Impurities" in the potassium hydroxide alleged to catalyze the exchange in a previous work was disproved. The hydroxyl ion concentration in the solution after reaction in a glass vessel was determined by means of pH meter; the pH decreased rapidly as the volume of the solution became smaller. It was concluded that the exchange reaction is catalyzed by hydroxyl ion and that the decay of catalytic activity of the solution is caused by the decrease in hydroxyl ion concentration through a reaction of alkali with glass of the reaction vessel. (auth)

40098 KINETICS OF ISOTOPIC EXCHANGE BETWEEN ACETYLACETONE-^{14}C AND TRIS-ACETYLACETONATO-ALUMINUM IN TETRAHYDROFURAN. Saito, Kazuo; Masuda, Kazuyo (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 41: 384-9(Feb. 1968).

Tris-acetylacetonatoaluminum [$Al(acac)_3$] is precipitated in crystalline form from tetrahydrofuran (THF) solution containing an excess of acetylacetone (acacH) by adding chilled petroleum ether. This enables a kinetic study to be made of isotopic exchange of $acac^-$ between [$Al(acac)_3$] and acacH with the aid of acetylacetone-^{14}C. The exchange rate is independent of the concentration of acacH and dependent on that of water. The rate formula at 25°C is as follows: $R = [Al(acac)_3](6 \times 10^{-5} + 2.0 \times 10^{-3}[H_2O])$ mol l^{-1} min^{-1}. This exchange reaction is catalyzed by acids; the stronger the acid, the greater the catalytic effect. One of the acetylacetonate ligands would be present with one end free, and break of the remaining bond of unidentate acetylacetonate seems to be the rate determining step. Water can occupy the vacant coordination site of aluminum ion to retard recombination of the unidentate ligand. The donation of proton to the free end of acetylacetonate appears to impede the recombination, too, and facilitate the exchange. Hydronium ion seems to be the unique proton carrier. (auth)

40099 A NEW METHOD OF LABELLING ROSE BENGAL WITH ^{131}I OR ^{125}I. Raban, P.; Gregora, V. (Charles' Univ., Prague). Int. J. Appl. Radiat. Isotop., 19: 361-7(Apr. 1968).

It was found that the formation of three colored by-products takes place during the labelling of pure rose bengal, i.e., tetraiodotetrachlorofluorescein (TITCF), with radioactive iodine by exchange reaction in acetate buffer at pH 5. The presence of labelled colored impurities in TITCF affects the results of liver chromoexcretion tests. Two methods for the preparation of radiochemically pure labelled TITCF are described. The first method uses adsorption chromatography for separating labelled TITCF from inorganic iodide as well as from the colored by-products. The second and more convenient method of labelling is based on an exchange reaction of TITCF with elementary radioiodine in ethanol–ether medium, in which no colored impurities are formed. This method allows the preparation of labelled TITCF of substantially higher purity than the methods employed so far, and it is also less time-consuming. The method was also proved suitable in the preparation of 3,5-diiodo-4-pyridone-1-acetic-^{131}I acid (Diodone, Diodrast). (auth) (UK)

40100 KINETICS OF ION EXCHANGE. I. EXCHANGE OF THE Me–H TYPE ON DOWEX 50 W. Eliasek, J.; Talasek, V. (Technische Hochschule, Prague). Collect. Czech. Chem. Commun., 33: 1501-7(May 1968). (In German).

The oscillometric determination of the conductivity changes of a solution can be used for the determination of the diffusion coefficients for the particle diffusion by a series of metals of varying valence using the ion exchanger Dowex 50 W. The effects of the size of the exchanger grains and the degree of crosslinking on the exchange velocity were investigated for the RH + Me system. The use of oscillometry was found to be very suitable since the inaccuracies are eliminated when the exchange proceeds very rapidly

and brings experimentally much simplification and acceleration of the determination. It eliminates also the difficulties in the analytical determination of some ions. It was found that the diffusion coefficients changed very little with the degree of crosslinking of the ion exchanger and with the valence change of the metal when Dowex 50 W with a granulation of 100/200 sifting is used. These changes are significant in granulation of 20/50 and increases with the degree of crosslinking of the exchanger and the valence of the metal. (tr-auth)

40101 NEUTRALIZATION ANALYSIS OF AQUEOUS SOLUTIONS OF SALTS OF TETRAVALENT URANIUM. Baran, V. (Inst. for Nuclear Research, Rez, Czech.). Collect. Czech. Chem. Commun., 33: 1561-9(May 1968). (In German).

A method for the potentiometric determination of the acids or bases given by the dissolution of salts of tetravalent uranium was developed. The method depends on the elimination of the interfering effects of U(IV) and uranyl ions by reaction with hydrogen peroxide, in which a given stoichiometric acid mass is free and passes into solution. With respect to this acid, a correction of the direct analysis consumption must be made according to the concentration of the tetra- and hexavalent uranium. Of all procedures tested, the proposed method is the best since it can be used at any concentration ratio of tetra- and hexavalent uranium since neither the consumption of titrant nor the height of the potentiometric jump is dependent on the peroxide excess. The potential appears sufficiently rapidly and the systematic error is comparable, for the most part, with the usual values of volumetric analysis. (tr-auth)

40102 THERMAL CONDUCTIVITY OF THE GAS MIXTURES: D_2–Xe, D_2–Ne–Kr, D_2–Ne–Ar, AND D_2–Ar–Kr–Xe. Mathur, S. (Univ. of Rajasthan, Jaipur, India); Tondon, P. K.; Saxena, S. C. J. Phys. Soc. Jap., 25: 530-5(Aug. 1968).

Thermal conductivity values of D_2-Xe, $D_2-Ne-Kr$, $D_2-Ne-Ar$, and $D_2-Ar-Kr-Xe$ systems, and of the related five pure gases, are reported at several compositions in the temperature range 40 to 90°C. The rigorous theory is only moderately successful in interpreting the results of the binary system when used in conjunction with Lennard-Jones (12-6) potential. However, the approximate and recently suggested semi-theoretical methods correlate the data of binary, ternary, and quaternary mixtures quite well. Certain simpler methods were also employed to compute thermal conductivity and these calculated values are compared with the directly observed ones. The conclusions so drawn are of considerable value in the prediction of multi-component thermal conductivity of mixtures involving polyatomic gases. (auth)

40103 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, TOKYO–KYOTO, 1966. PART 1. J. Polym. Sci., Part C, No. 23, 1–452(1968). (In English and French). (CONF-660964–(Pt.1)).

Fifty papers presented at the conference are included. Various properties of polymers are discussed. A separate abstract was prepared for one paper. (M.C.G.)

For an abstract of the individual paper see: 40147.

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Refer also to abstracts 40024, 40122, 40199, 40290, and 40878.

40104 (BNL–12552) MICROWAVE CAVITY METHOD OF STUDYING RECOMBINATION FOLLOWING PULSE RADIOLYSIS. Zucker, M. S. (Brookhaven National Lab., Upton, N. Y.); Ferrari, L. A. (Queens Coll., New York. Brookhaven National Lab., Upton, N. Y.). June 1968. 14p. (CONF-680806–1). Dep. CFSTI.

A method is reported for study of recombination in ionized media at neutral and charged particle densities that are so high that the usual methods of creating ionization are unsatisfactory. The pulsed 1.75-MeV electron beam from the accelerator is collimated and allowed to enter the gas-filled cylindrical cavity through a foil, causing a well-defined column of ionization coaxial with the cavity. The cavity is used as a microwave transmission filter and thus passes a maximum amount of microwave power when its resonant frequency equals that of the microwave signal generator. Data on the relation of electron density to time after passage of the electron pulse can be obtained by offsetting the frequency of the signal generator by successive amounts and photographically recording the resulting oscilloscope traces. (M.C.G.)

40105 (JINR–P12-3887) FAST RADIOCHEMICAL SEPARATIONS BASED ON THE SZILARD–CHALMERS-EFFECT IN LANTHANIDE COMPLEXES WITH POLYAMINEPOLYCARBOXYLIC ACIDS. II. COMPLEXES OF THE LANTHANIDES WITH DIETHYLENETRIAMINEPENTAACETIC ACID AS TARGETS TO BE EXPOSED WITH 660 MeV PROTONS. Baier, G. Yu.; Khalkin, V. A.; Grosse-Ryuken, Kh.; Pfrepper, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 12p. (In Russian). Dep.

Complexes of lanthanides with diethylenetriaminepentaacetic acid (DTPA) are proposed to be exposed to high-energy protons in order to reduce the time for preparation of neutron-deficient radioactive isotopes of the rare earths. The larger fraction of nuclear reaction products was in the form of ions due to the Szilard–Chalmers effect and easily separated from target material. These chelated compounds as targets in combination with selective chromatography make it possible to measure the gamma spectra of many radioactive isotopes with $T_{\frac{1}{2}} < 30$ min. (auth)

40106 (NYO–3383-13) STUDIES ON PRIMARY PROCESSES IN THE RADIATION CHEMISTRY OF LIQUIDS AND ON THE MECHANISM OF THE INTERACTION OF RADIATION WITH BIOLOGICALLY IMPORTANT CHEMICAL SYSTEMS. Progress Report, February 14, 1967–May 7, 1968. Trumbore, Conrad N. (Delaware Univ., Newark. Dept. of Chemistry). May 7, 1968. Contract AT(30-1)-3383. 13p. Dep. CFSTI.

Studies of several different chemical systems have led to speculation that there may be relatively long lived precursors of the commonly invoked intermediates in aqueous radiation chemistry, H, OH, and e^-_{aq}. In the pulse radiolysis of alkaline solutions a fast decay of what is thought to be the hydrated electron was found to be exceedingly sensitive to the addition of a compound which computer calculations show should not substantially affect this decay. In two other chemical systems, aqueous p-nitrosodimethylaniline and cysteine, nonclassical behaviour was demonstrated, especially at low pH and low solute concentrations. One possible interpretation of this phenomenon is an "excited" state or ionic precursor of water radicals which "decays" in competition with scavenging by a reactive solute. In the pulse radiolysis of the p-nitrosodimethylaniline system certain rate constants were found to be an order of magnitude above normal diffusion limited ones, implying very rapid energy transfer. Studies of the benzene–cyclopentanone system showed that there are similar excited states in the photochemistry and radiation chemistry of benzene and that the results of the photochemical and fluorescence studies demand either unorthodox explanations of the excited states involved or unusual spin-forbidden processes. (auth)

40107 COSMIC-RAY-PRODUCED RADIOACTIVITY IN LABORATORY CHEMICALS. Husain, L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3235. J. Inorg. Nucl. Chem., 30: 1121-4(June 1968). (ORO–3235-30).

^{127}Te and ^{32}P activities were radiochemically isolated from several kg quantities of potassium iodide, and hydrochloric and sulphuric acids, respectively, exposed to cosmic rays on the roof of the Chemistry Building of the University of Arkansas. The observed specific activities, in terms of disintegration ($\times 10^{-5}$)/sec were ^{127}Te: 1.1/g of iodine, ^{32}P: 3.8/g of sulphur and 2.0/g of chlorine. The measured values are in reasonable agreement with the calculated values and previous measurements. (auth) (UK)

40108 RADIATION CHEMICAL STUDIES OF PROTEIN REACTIONS: EFFECT OF PROTECTORS AGAINST RADIATION. Nisizawa, Mizuho (Defense Academy, Yokoiuka, Japan). J. Appl. Polymer Sci., 12: 1781-4(July 1968).

Sodium glutamate and sodium benzoate were found to protect reactions from radiation damage. The behavior of the viscosity changes was determined. The experimental equation for the protective effect is given by $\eta_{red}(\infty) = a(\log X)^2 + b(\log X) + c$, where $\eta_{red}(\infty)$ is the reduced viscosity of the solution at infinite time, X is the concentration of the radiation protectors, and a, b, and c are adjustable constants. (auth)

40109 NEW POLYOXYETHYLENE GLYCOL BASED PRODUCT. (to Centre National de la Recherche Scientifique). British Patent 1,117,032. June 12, 1968. Priority date Apr. 21, 1965, France.

A polyoxyethylene glycol based polymer was prepared by subjecting an aqueous solution of polyoxyethylene glycol to γ irradiation with an irradiation dose output higher than a critical output at which the viscosity of the aqueous solution remains substantially constant in the course of the irradiation. (B.L.M.)

40110 NEUTRON IRRADIATION METHOD OF SYNTHESIZING ETHYLENE GLYCOL AND FORMALDEHYDE. Hamling, Bernard H. (to Union Carbide Corp.). U. S. Patent 3,378,451. Apr. 16, 1968. Filed July 28, 1965.

A nuclear fuel in a stable solution in a polar organic compound is used to cause chemical synthesis. If the nuclear fuel is UCl_4 in a methanol solution, the principal reaction products are ethylene

glycol and formaldehyde. The solution should contain at least 4 g of UCl_4/l and is subjected to a thermal flux for a period of about 2 weeks. (B.L.M.)

40111 RADIATION-ENHANCED SURFACE ACTIVITY OF AN ORGANIC EXPLOSIVE, γ-HMX. Castorina, Thomas C.; Haberman, Jerome; Smetana, Andrew F. (Picatinny Arsenal, Dover, N. J.). Int. J. Appl. Radiat. Isotop., 19: 495-503(June 1968).

The surface activity of one-micron particle size γ-octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (γ-HMX) was studied as a function of cobalt-60 gamma irradiation in vacuo and in vapors of H_2O, NO, and NO_2. Changes in surface activity were measured by a radiometric determination of adsorption of carbon-14 labelled stearyl trimethyl ammonium bromide (STAB) from solution. Observed enchancement of surface activity is attributed to a 1-Mrad radioinduced adsorbate-substrate interaction which produces polar surface adducts. The mechanism of energy transfer from the bulk of the substrate to the surface-vapor phase interface suggested for various other substrates is postulated to apply to crystalline organic solids such as γ-HMX. (auth) (UK)

40112 ABSORPTION SPECTRA OF INTERMEDIATES FORMED DURING RADIOLYSIS AND PHOTOLYSIS. Habersbergerova, A.; Janovsky, I.; Teply, J. (Nuclear Research Inst., Prague). Radiat. Res. Rev., 1: 109-81(May 1968).

Data, published prior to 1967, were tabulated for the absorption spectra of solvated electrons in aqueous solutions, trapped electrons in aqueous glasses, solvated electrons in organic liquids, trapped electrons in organic glasses, inorganic free radicals and unstable ions, aliphatic and alicyclic free radicals, free radicals derived from aromatic compounds, free radicals derived from heterocyclic compounds, unstable positive ions derived from aliphatic and alicyclic compounds, unstable positive ions derived from aromatic and heterocyclic compounds, unstable negative ions derived from aliphatic and alicyclic compounds, and unstable negative ions derived from aromatic and heterocyclic compounds. (D.H.M.)

40113 METHODS OF PRODUCTION OF SOLVATED ELECTRONS AND THEIR CHEMICAL AND PHYSICAL PROPERTIES. Thomas, J. K. (Argonne National Lab., Ill.). Radiat. Res. Rev., 1: 183-208(May 1968).

Methods of producing solvated electrons are reviewed including alkali metals in liquid ammonia, alkali metals in water and alcohols, and photolytic production. Solvated electrons produced by low-intensity steady-state radiolysis, pulsed radiolysis, and electrons from hydrogen atoms are considered. Properties and rate processes of solvated electrons are also discussed. (D.H.M.)

40114 PRIMARY RADICAL AND MOLECULAR YIELDS IN AQUEOUS SOLUTION; THE EFFECT OF pH AND SOLUTE CONCENTRATION. Buxton, G. V. (Univ. of Leeds, Eng.). Radiat. Res. Rev., 1: 209-22(May 1968).

The radical and molecular yields in neutral solution are discussed with respect to the reducing radical, the oxidizing radical, and the solute concentration. The pH dependence of radical and molecular yields and the mechanisms of this dependence are also discussed. (D.H.M.)

40115 FUNDAMENTAL PROCESSES OF INERT-GAS SENSITIZATION. Brocklehurst, B. (Univ., Sheffield, Eng.). Radiat. Res. Rev., 1: 223-40(May 1968).

Major topics included in the review of the fundamental processes of inert-gas sensitization include: low-pressure studies (mass spectrometry, photo-sensitized reactions, and other methods); high-energy irradiations (energy absorption, decay processes in pure gases, ionization yields, luminescence of irradiated gases, and radiation chemistry); and excitation in discharges (resonance excitation, lasers, and discharge afterglows). (D.H.M.)

40116 CHANGES IN THE SELECTIVITY OF NEODYMIUM OXIDE UPON NEUTRON IRRADIATION IN THE DECOMPOSITION REACTION OF ISOPROPYL ALCOHOL. Spitsyn, V. I.; Pirogova, G. N.; Korosteleva, R. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 179: 1152-4(Apr. 11, 1968). (In Russian).

Following up studies on the changes in the selective catalytic effects of yttrium oxide on the decomposition of isopropyl alcohol, the similar behavior of neodymium oxide exposed to a 1.2×10^{13} n/cm^2/sec flux for 22 hours was investigated, examining how the dehydrogenation and dehydration rates are affected by the irradiation. The tests were carried out with Nd_2O_3 specimens, calcined at 600 or 900°C and containing primarily ^{141}Nd, allowing the ^{149}Nd to decay. On the basis of the results, it was proposed that neutron bombardment causes the formation of radioactive isotopes and radiation defects in the oxide; radiation from the radioactive isotope probably increases the dehydration rate, while the radiation defects decrease it. Heating of the catalyst after exposure anneals out the defects. The degree of transformation was only slightly affected but the selectivity with respect to dehydration was increased. (TTT)

40117 RADIOLYSIS OF NEUTRAL AQUEOUS SOLUTIONS OF CYSTEINE IN THE PRESENCE OF OXYGEN. Packer, J. E.; Winchester, R. V. (Univ. of Auckland, New Zealand). Chem. Commun., No. 14, 826-7(July 17, 1968).

It was found that in the presence of oxygen G(-RSH) and $G(H_2O_2)$ were greatly increased, and at the cysteine concentrations employed (1 to 3×10^{-3}M) the only S-containing products formed in significant amounts were cystine and H_2S. By measuring $G(H_2S)$ at various oxygen concentrations values were found for $(ke_{aq}^- + RSH)/ke_{aq}^- + O_2)$ in good agreement with those of others, employing different techniques. G(-RSH) and $G(H_2O_2)$ increased with cysteine concentration, but were independent of oxygen concentration. Reaction mechanisms are discussed. It is considered that the H_2O_2 is a product of a series of reactions initiated by thiyl radicals. (UK)

40118 RETENTION OF ^{18}F PRODUCED BY THE ^{19}F(n,2n) REACTION IN SOLID XeF_2 AND XeF_4. Adloff, J. P.; Schleiffer, J. J. (Centre de Recherches Nucleaires, Strasbourg). Inorg. Nucl. Chem. Lett., 4: 403-5(July 1968).

The behavior of recoiling F atoms in XeF_2 and XeF_4 was studied. Solid samples were irradiated with 14 MeV neutron for 30 min. After a few min. cooling to allow decay of ^{18}O the gamma spectrum showed only the 0.5 MeV annihilation peak, which disappeared with the characteristic 110 min. half-life of ^{18}F. From the results it was deduced that the total retention of radiofluorine was 100% in XeF_2 and 89 ± 2% in XeF_4. Recombination of fluorine by slow thermal isotopic exchange or annealing processes was shown to have a minor role. Considering that the ^{18}F recoil energy is well above the Xe–F bond energy the retention involves the recombination of hot fluorine atoms with Xe; or alternatively, the (n,2n) reaction may proceed as spallation-like process, the incoming neutron suffering an elastic collision with a neutron of the target nucleus, with emission of both neutrons. The ^{18}F atom acquires no momentum, but may be retained in a nuclear excited state, bonds being broken in the subsequent de-excitation step, the enhanced reactivity of recoiling and/or charged fluorine species again favoring recombination with Xe. The Szilard-Chalmers effects appeared to be similar in both fluorides. (UK)

40119 RADIATION CHEMISTRY TODAY. Allen, A. O. Brookhaven National Lab., Upton, N. Y.). J. Chem. Educ., 45: 290-5(May 1968). (BNL–12091).

The history of radiation chemistry is reviewed. Radiation sources for experimental work are described. The radiation chemistry of water and aqueous solutions is considered. Radiolysis of hydrocarbons, effects of radiation on polymers, and pulse radiolysis are also discussed. (M.C.G.)

40120 ORIGIN OF BOND-ENERGY EFFECTS ON HOT HYDROGEN ABSTRACTION. Baker, R. T. K. (Yale Univ., New Haven); Wolfgang, Richard. J. Amer. Chem. Soc., 90: 4473-4(July 31, 1968).

Measurements on the trends of mean energy of hot abstraction as a function of bond energy are reported. Hot hydrogen in the form of recoil tritium produced by the ^{3}He(n,p)T process was generated in various mixtures of protonated and deuterated alkanes. The tritium atoms are produced at very high velocities and lose energy in successive collisions until they react or are thermalized and removed by Br_2 scavenger. In pure hydrocarbons, most atoms react at relatively high energies. Upon addition of an inert gas moderator the probability of collision with reactant is diminished. The effect of moderation in six mixed systems are tabulated. Abstraction at the weaker C–H bond seems to occur at higher average energies. The magnitude of the effect of moderation is proportional to the difference in bond energies. These findings are consistent with previous results that abstraction by recoil tritium occurs, on the average, at higher energies than does displacement. They indicate that the mean energy of abstraction increases with decreasing bond strengths. (D.H.M.)

40121 SOME RECOLLECTIONS OF EARLY NUCLEAR AGE CHEMISTRY. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). J. Chem. Educ., 45: 278-89(May 1968).

Work on the Periodic Table, attempts to produce transuranium elements, and identification of radioactive materials produced by irradiation of uranium are reviewed, along with the discovery of fission, the isolation of plutonium, and predictions of further transuranium elements. (M.C.G.)

40122 RADIATION CHEMISTRY OF HYDROCARBONS. Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). pp 1-42 of Current Topics in Radiation Research. Vol. IV. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1968.

A discussion is presented on the interactions of radiation with hydrocarbons from the standpoint of the radiation physicist as well as the chemist. Emphasis is placed on the influence of phase on the radiation-hydrocarbon interaction. Radiation interactions with saturated hydrocarbon vapors are discussed in relation to the sequence of processes occurring in the interaction, the energetics of the interaction, and the types of ion-molecule reactions occurring in this interaction. The methods used for the study of gas reactions are also discussed and an example of these methods in use is presented. Radiation interactions with saturated hydrocarbon liquids are discussed in terms of electron or negative ion phenomena in liquids as opposed to gases, the radiolysis product yields and radical yields, the effects of radical scavengers on these yields, and the influence of hydrocarbon mixtures on these yields. Radiation interactions with olefines are discussed both in terms of ionic polymerization and its commercial applications and in terms of the ionic and free radical mechanisms of radiolysis. A discussion of aromatic molecules as affected by radiation is included. Phenomena relating to the energy states of the molecules during the interaction, including luminescence, are illustrated. By way of example, the radiolysis of benzene is discussed in terms of polymerization phenomena and radical formation. Brief mention is also made of a variety of radiation-hydrocarbon interactions including substituted aromatics, effects of LET on polymerization of aromatics, use of aromatics as indicators in the study of pulse radiolysis of transient processes in the irradiation of other substances, and the role of aromatic and other hydrocarbon compounds in radiobiology. (60 references) (E.R.B.)

40123 RADIATION CHEMISTRY OF ORGANO-NITROGEN COMPOUNDS. Garrison, Warren M. (Univ. of California, Berkeley). Contract W-7405-eng-48. pp 43-94 of Current Topics in Radiation Research. Vol. IV. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1968. (UCRL-17440).

Some of the recent investigations of reaction mechanisms in the radiolysis of bio-organic derivatives of nitrogen are presented. When OH radicals attack C-H linkages α to amino groups in amino acids, oxidative deamination occurs that yields ammonia and carbonyl. The reaction of e^-_{aq} with amino acid compounds in which only one carbon unit separates the amino and carbonyl is a reductive deamination that yields fatty acid derivatives. Hydroxyl radicals initiate oxidative degradation of substituted amines (including peptides) by attack at the C-H linkage of the α-carbon atom. Reductive deamination does not ensue when e^-_{aq} reacts with the peptide bond. Pyrimidine and purine bases react with OH and e^-_{aq} almost exclusively at the carbon-carbon double bond. When ionizing radiations act on solid glycine and alanine in the absence of oxygen the electron escapes the parent ion and is subsequently removed through addition to the adjacent C=O groups. Reduced intermediates lose ammonia on rearrangement. The radiation chemistry of bifunctional amino acids in the solid state is similar to that in oxygen-free aqueous solutions. This is not true of certain trifunctional amino acids, e.g., cysteine and cystine. Ionizing radiations cause main-chain scission at the NH-CH (R) linkage of solid peptide derivatives of the aliphatic α-amino acids resulting in formation of amides and fatty acids. There is evidence that main-chain scission also occurs at the CHR-CO linkage. 137 references. (W.M.B.)

40124 HETEROGENEOUS CATALYSIS AND IONIZING RADIATION. Mucka, Viliam (Inst. of Nuclear Physics, Prague). Chem. Listy, 62: 709-74(June 1968). (In Czech).

A brief review is given of experimental studies on the influence of ionizing radiation on various heterogeneous catalytic reactions. The first chapter is devoted to the effects of ionizing radiation on certain physical and physicochemical properties of solids (metals, semiconductors, and nonconducting substances). Interactions of ionizing radiation with solids and its effects on structure, electrical properties, and physicochemical processes with participation of solid phase are discussed in the second chapter. The influence of ionizing radiation on the catalytic properties of substances irradiated prior to or during the reaction is discussed. The heterogeneous catalytic processes taking place in radioactive catalysts are analyzed in chapter 3. Results of experimental studies of radiochemical processes taking place in the solid phase are tabulated. (333 references) (R.V.J.)

40125 ELECTRONS IN SOLUTION. Baxendale, J. H. (Univ. of Manchester, Eng.). pp 1-34 of Current Topics in Radiation Research. Vol. III. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons Inc., 1967.

Current available information is reviewed concerning the chemical reactions between the electrons, ejected in the ionization of polar liquids, and solutes before neutralization by the concomitant positive ions. The preliminary discussion includes the conductivity, energetics of solution, and spectra of solutions of metals. The effects of ionizing radiation on glass are discussed in terms of the products of both photolysis and radiolysis. The ionizing radiation chemistry and the photoionization of liquid systems is also discussed. Reactions of solvated electrons are discussed under the following topics: conditions for reactions of hydrated electrons; additions of solvated electrons to give anions; reduction of inorganic ions; electron reactions giving bond scission; and a comparison with H atom reactions. The state of the electron in solution is also discussed in relation to mobility, energetics, absorption spectra, and models for the solvated electron are given. 70 references are cited. (E.R.B.)

40126 GENERAL APPLICATION OF PULSE RADIOLYSIS TO CURRENT PROBLEMS IN RADIOBIOLOGY. Adams, G. E. (Mount Vernon Hospital, Northwood, Eng.). pp 35-93 of Current Topics in Radiation Research. Vol. III. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons Inc., 1967.

In pulse radiolysis the radiation dose must be delivered in a time that is short compared to the duration of the short-lived intermediates in order to obtain the free radical concentration necessary for direct observation. The most suitable sources of radiation are microwave linear accelerators and high-current pulsed Van de Graaff machines. Pulse lengths generally used fall in the range 0.2 to 5 μ^2/sec. Chemical reactions involving radioinduced free radicals can be followed by the change in light transmission in the radiation cell. Either kinetic, spectrophotometry, or flash spectroscopy may be used for analyses. The major reducing species produced from radiolysis of water is the hydrated electron (e^-_{aq}) that reacts rapidly with a wide variety of inorganic, organic and biological molecules. Various radiobiological problems such as chemically induced changes in radiosensitivity can be attacked by pulse radiolysis studies. 111 references. (M.M.B.)

40127 RADIOLYSIS OF ORGANIC COMPOUNDS. Valero, Ernesto Funes. pp 117-40 of Inst. Nac. Invest. Agron. Conf., 1965-66. (In Spanish).

The interaction of radiations with matter, especially organic substances, is briefly outlined. Linear energy transfer, LET, is defined. The most commonly used radiation units are given. A detailed outline is given of the radiolysis of water. The radiolysis of organic compounds, specifically amino acids, is summarized as a continuation of the analysis of water radiolysis. (J.S.R.)

40128 DEISTVIE YADERNYKH IZLUCHENII I RADIATSIONNAYA PRIVIVKA NA VOLKNAKH. (Radiation Effects and Radiative Grafting Polymerization in Fibers). Klein, G. A.; Osipova, L. Kh.; Tikhomolova, M. P.; Filippov, A. N. Moscow, Izdatel'stvo Legkaya Industriya, 1968. 220p.

A brief review is given on ionizing radiation and basic regularities of radiation-chemical transformations in polymers. The first chapter includes descriptions of various irradiation installations (electron accelerators, nuclear reactors, and isotopic devices) and ionizing radiation interaction with solids. Effects of ionizing radiation on natural and synthetic cellulose fibers and specific induced alterations in fiber properties by radioinduced graft polymerization are covered in the second chapter. Regularity aspects in polymerization processes induced by radiation-chemical methods are discussed in the third chapter. (363 references). (R.V.J.)

40129 RADIOLYSIS OF GASEOUS HYDROGEN BROMIDE: THE EFFECTS OF PRESSURE, BROMINE, AND AN APPLIED ELECTRIC FIELD. Lee, R. A. (Puerto Rico Nuclear Center, Mayaguez); Armstrong, D. A. Int. J. Appl. Radiat. Isotop., 19: 585-91(July 1968).

An ion pair yield of 4.7 for the decomposition of gaseous hydrogen bromide by ^{60}Co gamma rays was obtained using an ionization chamber method. A $G(H_2)$ value of 9.7 can be calculated from the W value for hydrogen bromide. Studies with added bromine and sulphur hexafluoride showed that about 30% of the hydrogen yield can be inhibited at scavenger concentrations of about 6 mole %. The remainder of the hydrogen yield is not easily suppressed, thereby indicating the presence of two hydrogen-forming species. An electric field applied during radiolysis caused no change in the hydrogen yield in the ion-recombination region, implying that ion neutralization processes are unimportant in the formation of hydrogen. (auth) (UK)

40130 CHEMISTRY OF RECOIL TRITIUM ATOMS. PART I. REACTION WITH n-BUTANE, n-PENTANE, AND neo-PENTANE. Urch, D. S.; Welch, M. J. (Queen Mary Coll., London). Trans. Faraday Soc., 64: 1547-59(June 1968).

The reactions of recoil tritium atoms with n-butane, n-pentane, and neo-pentane in the presence of about 2% oxygen (scavenger) and varying amounts of helium (inert moderator) are described. Using the Estrup-Wolfgang kinetic theory average molecular moderating parameters α were determined. Reactivity integrals

I_i, and K_i integrals, were also found. It is proposed that reactive and nonreactive collisions are essentially of the same (inelastic) type and that the ability of a paraffin molecule to absorb energy is related to the number of its fundamental vibrations. This model explains the observations that both $I(=\Sigma I_i)$ and α appear to increase with molecular size. (auth) (UK)

40131 RADIOLYSIS IN AN ELECTRIC FIELD. Tal'roze, V. P. Vestn. Akad. Nauk SSSR, 38: No. 5, 98-104(May 1968). (In Russian).

Earlier studies of the radiolysis of gases in an electric field indicated that application of the field may increase or decrease the usual rate of decomposition of the gas, depending on the rate of recombination of the charged particles and the acceleration of the slow electrons. The problem was further examined by studying the mechanism of the radiolysis of methane exposed to an 06 to 1.6-MeV electron beam in a chamber with an applied electric field. The first stage of the radiolysis, $CH_4 \rightarrow \begin{cases} CH_4^+ + e \\ CH_3^+ + H + e \end{cases}$, is followed by secondary ionic-molecular reactions and dissociative recombination. The results indicated that the additional decomposition of the methane, due to an increase of the electron temperature, should not be attributed to ionization but to excitation and dissociation processes involving neutral particles, e.g., $CH_4 + e \rightarrow CH_3 + H + e$. Recombination of secondary ions is responsible for 30 ± 10% of the total hydrogen formed. The electric field also affects the time of life of the ions. Application of the electric field on liquid hydrocarbons was found to increase the rate of radiolysis. (TTT)

40132 RADIOLYSIS OF CHLOROFORM IN THE INTENSE RADIATION PULSE FROM A NUCLEAR EXPLOSION. Bibler, N. E.; Hyder, M. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nature (London), 219: 374-5(July 27, 1968).

The intense burst of radiation from an underground nuclear explosion was employed to obtain dose rates of 10^{12} to 10^{13} R/sec. It was found that at these high dose rates $CHCl_3$ is no longer successful in scavenging all the radiolytically produced Cl-atoms (primary dissociation product). The experimental set-up is described, together with the technique employed. Variations in the cross-sectional distribution of the radiation appeared to be large and this, together with difficulties introduced by the complex nature of the radiation pulse, and the inability of the LiF dosimeters to measure absorbed doses accurately because of neutrons, prevented accurate estimation of the dose received by the $CHCl_3$. A conservative estimate for the dose rate in the $CHCl_3$ samples was 10^{12} to 10^{13} R/sec. The principal products and their average yields relative to C_2HCl_5 were: CH_2Cl_2 0.07 ± 0.01, C_2Cl_4 0.08 ± 0.01, sym-$C_3H_3Cl_3$ 0.21 ± 0.04, C_2Cl_6 0.31 ± 0.04, and sym-$C_2H_2Cl_4$ 1.2 ± 0.1. The main inorganic products, Cl_2 and HCl, were not measured. All of the measured products, except sym-$C_3H_3Cl_3$, are major products in the radiolysis of $CHCl_3$ at low intensities. It is believed that sym-$C_3H_3Cl_3$ was formed by reaction of the cis-$C_2H_2Cl_2$ impurity present in the samples. Results are discussed, together with mechanisms. At all intensities it appeared that sym-$C_2H_2Cl_4$, C_2HCl_5, C_2Cl_6, and CH_2Cl_2 accounted for >94% of the decomposed $CHCl_3$. Relative yields at 10^{10} R/sec were also obtained using an electron accelerator capable of generating 20 nsec x-ray pulses. It appeared that the same decomposition mechanism was probably applicable at all dose rates. (UK)

40133 MORPHOLOGICAL STUDY OF THE PRECIPITATE OF METALLIC GOLD FORMED BY IRRADIATION OF SOLUTIONS OF GOLD CHLORIDE. Rashkov, Stephane; Koulkes-Pujo, Anne-Marie (Institut de Physique Nucleaire Laboratoire Curie, Paris). J. Chim. Phys., 65: 911-19(May 1968). (In French).

The precipitation of metallic gold from aqueous solutions of gold chloride under the effects of γ radiation from ^{60}Co was studied. The effects of concentration, temperature, O_2, pH, NaCl, and N_2O on the precipitation and crystalline aspects were determined. The growth of Au crystals becomes more regular with an increase of the Au^{3+} concentration and with decrease of the temperature. O_2 has no significant effect, but the tail noted in precipitation from deaerated solutions is not present. The decrease of the pH improves the regularity of the crystalline growth, as does the presence of NaCl. In the presence of N_2O there is no precipitation of gold. Possible mechanisms for the crystallization of Au under these conditions are discussed. (J.S.R.)

40134 RADIOLYSIS OF ALKALINE SOLUTIONS OF SODIUM PERSULFATE. Buu, Antoinette (Institut du Radium, Paris). J. Chim. Phys., 65: 731-3(Apr. 1968). (In French).

Previous studies on the radiolysis of sodium persulfate in acid and neutral solution indicated that the total reactions occurring can be expressed by the mechanism $H_2O + S_2O_8^{=} + OH + HSO_4^- \rightarrow 3SO_4^{=} + O_2 + 4H^+$. As Caro acid is very unstable in alkaline solution, a study was made to determine whether its thermal decomposition at high pH is rapid enough to compete with its radioreduction by the preceding mechanism. This would modify the total reduction yield. The experimental results showed that the modification of the radioreduction mechanism of persulfates in alkaline medium can be attributed to the instability of Caro acid. The effect of high concentrations on the reduction yields appears due to the intervention of $S_2O_8^{=-}$ in regions of high radical density. This leads to a progressive inhibition of the formation of molecular hydrogen and of the inverse recombination reaction H + OH. (J.S.R.)

40135 PREPARATION OF CARRIER-FREE ^{90}Y OF HIGH PURITY. Groll, P.; Grass, F.; Buchtela, K. (Oesterreichische Hochschule, Vienna. Univ., Vienna). J. Radioanal. Chem., 1: 179-80(Mar. 1968).

In the method described for preparing ^{90}Y of high purity, an ion-exchange membrane is employed in an electrodialytic process. The membranes were prepared from 40-μ thick polyethylene foil, which was sulfochlorinated and reacted with ethylenediamine. The electrodialytic apparatus is described. The electrolyte for the electrodialysis was 10^{-3}M ethylenediaminetetraacetic acid disodium salt (EDTA = Na_2H_2A; pH = 5.5). At this pH Y forms an anionic complex with EDTA (YA^-), whereas Sr remains a cation. The purity of the resulting ^{90}Y solution in the anodic chamber was tested by decay curve analysis. The decontamination factor calculated from the decay curve was $>10^6$. From this curve the half-life of ^{90}Y was also determined (63.46 ± 0.13 hr), using the method of least squares. The degree of purity can be improved by addition of Sr hold-back carrier. The estimated decontamination factor would then be $>5 \times 10^7$ to 10^8. Such high purity ^{90}Y is preferred for radiotherapy techniques where the presence of ^{90}Sr would be undesirable. (BBB)

40136 TRANSFER PROCESS IN IRON CUPFERRATE. Calusaru, A.; Rusi, A. (Inst. of Atomic Physics, Bucharest). Radiochim. Acta, 9: 1-6(May 1968). (In French).

The transfer of activity from $Fe(OH)_3$ to iron cupferrate during thermal annealing was characterized by isotherms which meet in one plateau. No transfer of activity took place in the presence of radioactive Fe(II) only. In the presence of Fe(III) however, a transfer of activity from Fe(II) to iron cupferrate was observed after an induction period that was temperature dependent. Different values were found for the transfer reaction and the retention depending on whether or not the activity in the form of Fe(II) was taken into account. Several examples are discussed where the transfer reaction and the thermal annealing reaction in iron cupferrate is preceded by an oxidation reaction due to recoil of Fe(II). By comparing the values of the velocity constants of the different reaction steps it was found that the plateau appears to be sensitive to kinetics because the height of the plateau is determined by the velocity of the preceding oxidation reaction. The plateau was less pronounced in the case of neutron bombardment of iron cupferrate. (auth)

40137 RELATION OF THE DECAY OF FREE RADICALS IN IRRADIATED POLYETHYLENE TO THE MOLECULAR MOTION OF THE POLYMER AND THE CONFIGURATIONS OF THE FREE RADICALS. Nara, S.; Shimada, S.; Kashiwabara, H.; Sohma, J. (Hokkaido Univ., Sapporo). J. Polym. Sci., Part A-2, 6: 1435-49(Aug. 1968).

Decay reactions of the free radicals produced in irradiated polyethylene (high-density and low-density materials) were examined in connection with the molecular motion of the matrix polymer. Three temperature regions, in which the free radicals decay very rapidly, at around 120, 200, and 250°K, were designated T_A, T_L, and T_B, respectively. The decay of the free radicals at these temperatures had activation energies in high-density polyethylene of 0.4 kcal/mole for T_A, 9.4 kcal/mole for T_L, and 18.4 kcal/mole for T_B. In low-density polyethylene these quantities were 0.7 kcal/mole for T_A, 23.1 kcal/mole for T_L, and 24.8 kcal/mole for T_B. Comparison of time constants for the decay reactions and for molecular motion of the matrix polymer indicate that the decay in T_A and T_B is closely related to molecular motion in the amorphous regions of the polymer. The decay of the free radicals at T_L in high-density polyethylene is due to molecular motion associated with local mode relaxation at lamellar surfaces, while that of low-density polyethylene is due to local mode relaxation in the completely amorphous region. Steric configurations of the free radicals which decay in the respective temperature regions were also investigated. (auth)

40138 SZILARD–CHALMERS REACTIONS IN AROMATIC BISMUTH AND THALLIUM COMPOUNDS. Wheeler, Owen H.; Trabal, J. Elisa; McClin, Maria Luisa (Univ. of Puerto Rico, Mayaguez). Radiochim. Acta, 9: 49-51(May 1968).

Studies were made on Szilard-Chalmers reactions in triphenyl- and diphenylbismuth chloride and diphenylthallium chloride. Samples were activated for 1 hr in sealed ampoules in the PRNC

swimming pool reactor. The behavior of the bismuth compounds in n,γ reactions was contrasted to the β-decay of ^{210}Bi compounds. The processes did not involve radioactive recoil, but rather the splitting off of a carbonium ion to stabilize the intermediate organometallic cation. When diphenylthallium chloride was activated for longer periods, the retention of activity in the original compound increased and there was a corresponding decrease in the amount of radioactive inorganic thallium. The activity of the phenylthallium dichloride fraction (eluted with water) decreased only when the sample was activated for 12 hr. (P.C.H.)

40139 IONIC SPECIES IN THE RADIOLYSIS OF CYCLOHEXANE. Sato, Shin (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap., 41: 304-6(Feb. 1968).

A diffusion model proposed in the previous paper (Bull. Chem. Soc. Japan, 40: 1818 (1967)) was applied to explain the ionic reactions occurring in the γ radiolysis of cyclohexane. The effects of an electron scavenger (N_2O) and a positive ion detector (CH_3OD) were consistently interpreted. The ratio of the diffusion coefficient of electrons to that of parent positive ions was estimated from the calculation to be in the range from 4 to 5. The calculating method was compared with that recently published by Freeman (J. Chem. Phys., 46: 2822 (1967)). (auth)

40140 ELECTRON SPIN RESONANCE OF X-IRRADIATED SINGLE CRYSTALS OF ZINC ACETATE DIHYDRATE: HINDERED ROTATION OF METHYLENE GROUP IN A FREE RADICAL CH_2COO^-. Ohigashi, Hiroji; Kurita, Yukio (Toyo Rayon Co., Ltd., Kamakura, Japan). Bull. Chem. Soc. Jap., 41: 275-84 (Feb. 1968).

Electron spin resonance spectra of x-irradiated single crystals of zinc acetate dihydrate were studied at 9.2 Gc in the temperature range from 77 to 380°K. The radicals trapped at 77°K are CH_3 and CH_2COO^-. The former disappears above 150°K. The latter is stable and persists up to 370°K. The principal values of hyperfine coupling constants for two identical hydrogens of the radical CH_2COO^- were found to be 10.5, 20.6, and 33.4G. The CH_2 group in the radical undergoes restricted rotation about the C–C bond. Analysis of the ESR spectra at different temperatures with a modified Bloch equation shows the activation energy and the frequency factor for the restricted rotation to the 5.8 ± 0.2 kcal/mol and $(4.4 \pm 2.7) \times 10^{12}$ sec^{-1}, respectively. (auth)

40141 THEORETICAL DERIVATION OF SEPARABLE YIELD IN DYNAMIC EXTRACTION OF RECOIL PRODUCTS FROM AN ION EXCHANGER LOADED WITH TARGET ION DURING NEUTRON IRRADIATION. Matsuura, Tatsuo (Rikkyo Univ., Japan); Ishiwara, Akira. J. Nucl. Sci. Tech. (Tokyo), 5: 350-3(July 1968).

As a contribution to the dynamic irradiation-elution method using an ion exchanger, in which, during the progress of irradiation, the product resulting from irradiation is immediately separated on recoil from the complex-ion target adsorbed on an ion exchanger, the concentration of the separable recoiling species remaining in the bead and the film of the ion exchanger in stationary condition was derived theoretically as a function of bead radius, with parameters to account for various other factors such as initial yield, film thickness, recombination rate constant of the recoiling species, and their diffusion coefficients. The equation derived for the separable yield was applied successfully to the analysis of experimental results obtained on trioxalatochromium ion adsorbed on an ion-exchange resin. (auth)

40142 UTILISATION OF THE FRICKE DOSIMETER FOR EVALUATING THE BIOLOGICAL RADIATION PROTECTIVE POTENTIAL OF WATER SOLUBLE ORGANIC COMPOUNDS. Jayson, G. G. (Liverpool Regional Coll.); Wilbraham, A. C. Chem. Commun., No. 11, 641-2(1968).

While the presence of organic impurities in irradiated Fricke dosimeter solutions usually leads to increased ferric yields, addition of cystamine produces a marked decrease of yield. This finding is the basis of the described method of radiation protection evaluation. Cysteamine and both oxidized and reduced glutathione also produce similar effects. Fricke solutions containing cystamine sulphate were X-irradiated at G58R/min under both aerated and deaerated conditions. From the ferric yields/dose curves, which were linear through the origin, $G(Fe^{3+})$ values were calculated and plotted as a function of added cystamine. A common limiting value of 4.5 was obtained for both aerated and deaerated systems. Since under the irradiation conditions employed cystamine does not react with H_2O_2, the interference must be with the $Fe^{2+}/.OH$ and $Fe^{3+}/.O_2H$ interactions. An interpretation is proposed to account for the observations, including the numerical value of the limiting ferric yield, at high cystamine concentrations, in the presence or absence of oxygen. (UK)

40143 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, BRUSSELS–LOUVAIN, JUNE 12–16, 1967. PART 1. J. Polym. Sci., Part C, No. 22, 1-545(1968). (In Several Languages). (CONF-670650–(Pt.1)).

Forty-two articles are included; separate abstracts were prepared for 3. The remaining 39 articles contain information on: polymerization of organic and inorganic compounds; structure of polymers; preparation of diolefin homopolymers with equimolecular binary microstructures; reactivities in polymerization reactions; composition of polymers; thermal degradation of poly(vinyl acetate); and polycondensation. (P.C.H.)

For abstracts of individual papers see: 40144–40146.

40144 THE MECHANISM OF RADIATION-INDUCED IONIC POLYMERIZATION. Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). J. Polym. Sci., Part C, No. 22, 15-31(1968).

From International Symposium on Macromolecular Chemistry, Brussels–Louvain, Belgium.

The radioinduced ionic polymerization of bulk styrene has been studied under extremely dry conditions. It was found that the rate of propagation increases with more rigorous drying of the monomer, and this effect is accompanied by a change in the exponent n for the doserate dependence of rate of polymerization from n values near unity to 0.6. A mechanism involving bimolecular termination of free ions is thereby indicated. The k_p value is estimated to be $>3.5 \times 10^6$ l $mole^{-1}$ $sec.^{-1}$ by the electric conductivity method. The large k_p value is explained as a characteristic ion dipole reaction for the free-ion propagation process and by the considerable freedom of the growing end of a free ion in comparison with that of an ion pair end. Similar results have been observed with isobutene, nitroethylene, and cyclic monomers such as trioxane and BCMO. The initiation mechanism induced by the ion radical formed by radiation was confirmed by direct observation with ESR, optical absorption, and mass spectrometry. (auth)

40145 INFLUENCE OF THE STRUCTURE OF POLYPROPYLENE FIBERS ON THE RATE OF GRAFTING AND THE STRUCTURAL CHANGES CAUSED BY GRAFTING. Odor, Louise (Research Inst. for Plastics, Budapest). J. Polym. Sci., Part C, No. 22, 477-92(1968).

From International Symposium on Macromolecular Chemistry, Brussels–Louvain, Belgium.

An investigation of the relation between the structure of polypropylene fibers and grafting showed that the grafting process takes place in the amorphous phase of the fiber up to 50% grafted polymer content and that the crystals are destroyed only above 75%. This was proved by the diffusion constant of the monomer in the grafted fibers and also by x-ray diffraction. The studies of grafting rates and diffusion rates of monomers showed that the differences in diffusion rate of monomer in fibers of different structures do not affect the rate of chain growth but do affect that of chain termination. The initial rate of grafting was affected by the amount, orientation, and segment mobility of the amorphous part. The chains of the basic polymer were disoriented by grafting, which was indicated by the sudden decrease of birefringence and crystalline orientation. The tensile strength of grafted fiber decreased as the structure changed. (auth)

40146 OBTAINING SEMIPERMEABLE MEMBRANES WITH REMARKABLE PROPERTIES BY RADIOCHEMICAL GRAFTING OF POLYTETRAFLUOROETHYLENE FILMS. Bex, G.; Chapiro, A.; Huglin, M. B.; Jendrychowska-Bonamour, A. M.; O'Neill, T. J. Polym. Sci., Part C, No. 22, 493-9(1968). (In French).

From International Symposium on Macromolecular Chemistry, Brussels–Louvain, Belgium.

Semipermeable membranes were prepared by grafting bulk Teflon films with acrylic acid, 4-vinylpyridine, and both monomers together by a method of successive grafting. Some kinetic features of these reactions are described. The swelling of the grafted membranes was investigated. In the case of vinylpyridine grafts the swelling properties were also examined after quaternization of the pyridine groups by HCl. A wide variety of membranes can be prepared by the methods described. These membranes exhibit excellent mechanical properties, even in the swollen state, and withstand remarkably well various corrosive media. (auth)

40147 GRAFTING ACRYLIC ACID TO STARCH BY PREIRRADIATION. Reyes, Zoila (Stanford Research Inst., Menlo Park, Calif.); Syz, Martin G.; Huggins, Maurice L.; Russell, C. R. J. Polym. Sci., Part C, No. 23, 401-8(1968).

The grafting of acrylic acid (AAc) to starch was investigated with gamma-preirradiated starch and aqueous solutions of AAc. The rate of grafting increased initially with time, then decreased, and approached zero when the percentage grafting reached a maximum value. At a given radiation dose the rate of grafting was proportional to the first power of the concentration of irradiated starch and to the 1.5 power of the initial concentration of AAc. Solvent effects on degree of grafting, molecular weight, and num-

ber of grafted branches were evaluated. Higher degrees of grafting were achieved with electron-irradiated starch at radiation doses lower than those used with gamma rays. (auth)

Radiochemistry

Refer also to abstracts 40054 and 40121.

40148 VALENCE STABILITY OF ^{238}Pu IN DILUTE NITRIC ACID. Silver, G. L.; Buzzelli, O. R. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. J. Inorg. Nucl. Chem., 30: 1317-22(June 1968). (MLM-1442J).

The nature of the equilibrium of plutonium-238 in dilute HNO_3 and the kinetics of the reduction of hexavalent plutonium-238 by what appears to be the effects of the alpha radiations of this isotope are discussed. (auth) (UK)

Separation Processes

Refer also to abstracts 39997, 39998, 40029, 40030, 40044, 40050, 40052, 40054, 40061, 40062, 40107, 40275, 40292, 40375, 41095, 42019, 42158, and 42203.

40149 (AEET/MET-9) STUDIES IN THE BENEFICIATION OF LOW GRADE URANIUM ORE CONTAINING TRACES OF Ni, Cu, AND Mo FROM JADUGUDA-BIHAR. Midha, P. P.; Majumdar, K. K. (Atomic Energy Establishment, Trombay (India)). 1966. 9p. Dep.

For the recovery of copper, nickel, and molybdenum in addition to U_3O_8 from low-grade Jaduguda ore, the ore should be wet ground to 38%-200 mesh and floated with a combination of reagents, including a promoter for nickel minerals and a dispersant for siliceous gangue. The bulk concentrate on reflotation will give a concentrate approximately as follows: Cu, 7.71% (54.0%); Ni, 6.0% (39.0%); MoO_3, 1.30% (56.5%); and U_3O_8, 0.4% (6.0%). The figure in parenthesis indicates recovery. The tailings on wet tabling would give a concentrate assaying 0.18% U_3O_8 with a recovery of 72.7%. It is possible to separate molybdenite as a separate constituent by repeated flotation by depressing other sulfide minerals by a cyanide or a sulfide. The tailings from molybdenite flotation are sufficiently rich in copper and nickel for metallurgical treatment. (auth)

40150 (ANL-7372) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XVI. THE FLUORINATION OF UO_2-PuO_2-FISSION-PRODUCT OXIDE PELLETS WITH FLUORINE IN A 2-INCH-DIAMETER FLUID-BED REACTOR. Anastasia, L. J.; Alfredson, P. G.; Steindler, M. J.; Redding, G. W.; Riha, J. G.; Haas, M. (Argonne National Lab., Ill.). Dec. 1967. Contract W-31-109-eng-38. 84p. Dep. CFSTI.

Fluorination of uranium and plutonium oxides to the volatile hexafluorides was studied in a 2-in.-diam fluid-bed reactor using a fluid bed of refractory alumina and simulated spent-fuel pellets containing UO_2, PuO_2, and nonradioactive fission product (F.P.) oxides. The fluorination conditions required to minimize the retention of uranium and plutonium in the alumina bed, which is discarded as waste from the process, were studied. Two general methods of reacting the pellets were used. In the two-zone method, the pellets were oxidized to fine particles of U_3O_8-PuO_2 in the bottom of the reactor. Simultaneously, the fines were transported by fluidizing action to the upper part of the reactor and there fluorinated to the volatile hexafluorides. The alternative procedure was to pulverize the pellets to fines by oxidation and then to complete the fluorination in a separate step. A pellet-to-alumina charge ratio of 0.6, consisting of 1100 g of alumina and 650 g of pellets (containing 560 g uranium and 2.8 g plutonium), was generally used in an experiment. With either method, approximately 80 to 100% of the uranium and about 20 to 75% of the plutonium in the pellet charge were reacted after completion of the initial fluorination step. More than 99.5% of the uranium charge from the alumina bed could be routinely removed. Plutonium material balances of 97% were demonstrated when separate collection of most of the UF_6 product in cold traps and most of the PuF_6 product in NaF chemical traps was used. The total plutonium holdup in the reactor, about 5% of the charge, was represented by plutonium contained in fines adhering to the interior walls and filters. A thermal conductivity cell was used to obtain information on fluorine utilization and the rate of reaction for the major species, uranium. The limited data were analyzed statistically, using multiple-regression and least-squares techniques. The calculated correlation coefficients indicated that the residual plutonium in the alumina bed had a significant correlation with the UF_6 and PuF_6 production rates during the two-zone step. When the pellets were processed by the two-zone method of oxidation and fluorination, residual levels in the alumina bed of 0.003 to 0.010 wt % uranium and 0.006 to 0.010 wt % plutonium were routinely accomplished, using a recycle-fluorination sequence totaling 12 to 20 hr. These residual levels corresponded to less than 0.1% of the uranium and 2.4 to 3.9% of the plutonium charged to the reactor. However, when cesium fluoride was added to the alumina bed at the start of a run to make the fission product distribution more representative of radioactive fuel, residual plutonium in the alumina bed increased. With cesium added, the best recycle-fluorination sequence following the two-zone method of processing the pellets appeared to be 1 hr at 450°C, 3 hr at 500°C, and 4 to 5 hr at 550°C. With this sequence, pellet-to-alumina charge ratios of 0.3 to 1.2 were processed leaving 4.7 to 7.5% of the plutonium charge in the alumina bed. Fluorinating uranium at 350°C and starting the recycle-fluorination at 350°C, rather than at 450°C as in the two-zone step, appeared to overcome the effects of the added cesium on residual plutonium in the alumina bed. The recommended recycle-fluorination sequence of 3 hr at 350°C, 6 hr at 350 to 550°C, and 1 hr at 550°C was effective in reducing plutonium in the alumina bed to 0.009 wt % plutonium, which corresponded to 3% of the plutonium charged for pellet-to-alumina charge ratios of 0.6. This recycle-fluorination sequence was used to process three batches of fuel pellets using only a single batch of alumina. An additional 3 hr of recycle-fluorination at 550°C was used in the recycle sequence for the third batch of pellets, giving a total recycle-fluorination time of 33 hr. The final alumina bed contained 0.009 wt % uranium and 0.009 wt % plutonium, which corresponded to less than 0.01% of the total uranium and 1% of the total plutonium charged to the reactor in the several batches of fuel pellets. The alumina bed was not significantly altered physically or chemically during these alumina reuse experiments, and a single alumina bed can probably be used to process several batches of irradiated fuel pellets, thus reducing the total plutonium losses in the waste alumina from the fluid-bed fluoride-volatility process. (auth)

40151 (BNWL-240) PROCESS FOR THE DISSOLUTION OF ALUMINUM-CLAD THORIA FUEL ELEMENTS. Phillips, J. F.; Huber, H. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 36p. Dep. CFSTI.

In an effort to develop a process for simultaneous dissolution of thoria and its C-64 aluminum alloy container, the following properties were measured: activation and dissolution characteristics of C-64 aluminum in mercury-catalyzed nitric acid-nickel(II) nitrate solutions; thoria dissolution rates in nitric acid-hydrogen fluoride-aluminum nitrate-thorium nitrate solution; and the solubility of thorium nitrate in nitric acid-aluminum nitrate. On the basis of the data obtained, the following codissolution process was recommended: activate and dissolve the containers in 10.0M HNO_3, 0.045M HF, 0.10M $Al(NO_3)_3$, 0.0120M $Hg(NO_3)_2$, 0.04M-0.05M $Ni(NO_3)_2$; and when the aluminum is partially dissolved, add additional HNO_3-HF solution and dissolve the now-exposed thoria to 0.55M-0.65M $Th(NO_3)_4$. (auth)

40152 (CEA-R-3449) PROBLEMES TECHNIQUES ET ECONOMIQUES LIES AU DEVELOPPEMENT DES METHODES DE TRAITEMENT ET D'UTILISATION DES DECHETS RADIOACTIFS. (Technical and Economic Problems Associated with the Development of Methods of Processing and Using Radioactive Waste). Thiriet, Lucien; Sauteron, Jean; Oger, Claude (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1968. 23p. (In French and English). Dep.

A brief review is given of the various techniques used in processing the radioactive wastes from the generation of electric power from nuclear sources. The relative importance, in nuclear fuel cycles, of the problem raised by these wastes is defined. Emphasis is placed on the economic influence of management policies on the cost of power generation, and hence on the relative position of nuclear energy. A substantial percentage of these wastes can be economically utilized. Attention is drawn to the major technical and economic features of the industry which will come into being as a result of this utilization. The major uses anticipated are discussed: (1) radiation sources, (2) heat sources, and (3) auxiliary power generation. It is concluded that satisfactory solutions have already been found to these problems, and possible improvements are discussed. (auth)

40153 (CEA-R-3469) PARTITION CHROMATOGRAPHY SEPARATION USING TRILAURYLAMINE ADSORBED ON A SOLID SUPPORT. BEHAVIOUR OF THE URANYL ION. Petit-Bromet, Marguerite (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1968. 96p. (In French). Dep.

The extractive phase is made up of a TLA solution in cyclo-

hexanol adsorbed on a solid polytrifluorochloroethylene support (sold commercially as voltalef or KEL-F). The mixture obtained is homogeneous and can be used for partition chromatography. For a solution of hydrochloric acid stronger than 1M, the amine is quantitatively in the form of the chlorohydrate. The partition curve for U(VI) between the 2N hydrochloric acid aqueous phase and the organic TLA phase has two steps, which can be explained by assuming that two complexes exist in the organic phase. The equilibrium constants for extraction were determined. The homogeneity of the voltalef-amine mixture made it possible to build up a column with reproducible characteristics. Under the operational conditions adopted, the height of the equivalent theoretical plate is about 3 mm. A plot of all the curves giving the variations in the partition function of U(VI), Fe(III), Cu(II), Sr(II), and Cs(I) as a function of the hydrochloric acid concentration makes it possible to predict the conditions under which these elements may be separated. (auth)

40154 (CEA-R-3478) STUDY OF IMMISCIBILITIES IN THE TRILAURYLAMINE–DODECANE–NITRIC ACID–PLUTONIUM SYSTEM. Saey, Jean-Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1968. 110p. (In French). Dep.

Phase equilibrium in systems made up of trilaurylamine, dodecane, nitric acid, and tetravalent plutonium is shown by drawing the triangular diagrams. The study of these diagrams provides information concerning the causes of immiscibility. Heterogeneity of the organic mixtures can be related to some characteristics of the components, dipole moment, molecular polarizability, and hydrogen bond exchanging ability. Depending on these, some rules may be established that can be used to make a proper choice of an additive in order to improve the miscibility. Studies were carried out showing possible improvements to the extraction process. (auth)

40155 (CEA-R-3506) ELIMINATION OF DILAURYLAMINE FROM THE TRILAURYLAMINE–DODECANE SOLVENT. Germain, Michel; Bathellier, Andre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr. 1968. 47p. (In French). Dep.

Dilaurylamine and carboxylic acids are the main degradation products of the trilaurylamine solvent. Dilaurylamine can be separated from the TLA by the precipitation of very slightly soluble dilaurylammonium salts. The main factors governing this removal and the subsequent filtration were studied. The chemical stability of the solvent after the above treatment using different salts was measured. From these considerations it appears that dilaurylammonium formate precipitation gives satisfactory results. (auth)

40156 (EURAEC-2031) THE REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 31, October 1–December 31, 1967. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7-RCIB(RD); 016-65-1-RAP-B. 53p. (EUR-3985). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Further studies concerning the kinetics of the fluorination of UO_2 and PuO_2-UO_2 mixtures using ClF_3 were carried out by thermogravimetry. The rate of fluorination was proportional to the surface accessible to the gaseous reagent, and the reaction rate increases considerably with temperature. Work on constructing a subassembly processing unit is progressing satisfactorily. Chemical decladding tests using 40% HF and 60% oxygen were continued. Work on constructing and assembling the hot thermobalance and the cell for storing, transferring, and conditioning samples was continued. Several methods of analysis were developed for assaying small quantities of plutonium. (M.C.G.)

40157 (JINR-P12-3886) FAST RADIOCHEMICAL SEPARATIONS BASED ON THE SZILARD–CHALMERS-EFFECT IN LANTHANIDE COMPLEXES WITH POLYAMINE–POLYCARBOXILIC ACIDS. I. SEPARATION OF GENETICALLY COUPLED ISOBAR AND ISOMER PAIRS. Baier, G. Yu.; Khalkin, V. A.; Grosse-Ryuken, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 19p. (In Russian). Dep.

Batch and continuous methods for separating genetically coupled isobar and isomer lanthanide pairs were developed, based on the Szilard-Chalmers effect in lanthanide complexes with ethylenediaminetetraacetic acid (EDTA) and diethylenetriaminepentaacetic acid (DTPA). Better results were obtained using DTPA. In the case of the batch method for separations of $^{134}Ce/^{134}La$, $^{140}Nd/^{140}Pr$, and $^{169m}Ho/^{169}Ho$ the yield of daughter isotopes was 70%, whereas mother isotope admixture was 0.05 to 0.5%. In the case of continuous separation of ^{140}Pr from ^{140}Nd adsorbed as a complex with DTPA using an anion exchange column, the yield of the daughter isotope was 30 ± 15%, whereas the admixture was 0.25 ± 0.05%. (auth)

40158 (K-L-1780(Pt,25)) ORGDP FUEL REPROCESSING STUDIES. Progress Report for Period Ending February 29, 1968. Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 12, 1968. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Factors influencing U_3O_8 elutriation during oxidation in the fluoride volatility process were studied in 4 semiworks runs. High system backpressure did not significantly increase the U_3O_8 elutriation rate from the reactor. HCl pretreatment caused an increase in the rate of U_3O_8 elutriation and increased the selectivity for uranium elutriation from an $Al_2O_3-U_3O_8$ mixture. The cumulative weight of U_3O_8 elutriated increased approximately linearly with time for runs with oxidation cycles less than 8 hr when the oxidation was not preceded with HCl treatment. Long-term operation of the peripheral compressor as well as the multicycle exposure testing of the sintered nickel filters in volatility process gases was continued, and the performance of a sodium fluoride bed in the recovery of uranium from low-concentration UF_6 gases was evaluated. Scoping calculations are being made to assess some of the problems associated with the application of the fluoride volatility process to fast breeder reactor fuel reprocessing. (M.C.G.)

40159 (KFK-tr-229) UBER DEN EINFLUSS EINES SYNTHETISCHEN DETERGENS AUF DIE BEHANDLUNG RADIOAKTIVER ABWAESSER NACH DER AUSFLOCKUNGSMETHODE. (On the Influence of a Synthetic Detergent on the Treatment of Radioactive Waste According to the Precipitation Method). Ito, F. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe, West Germany), from Yosui to Haisui, 6: 921-6(1964). 22p. (In German).

Synthetic detergents in waste water exert an influence on the processing of water by a precipitation method. The effect exerted on the flocculation and precipitation increased with increasing detergent concentration. This influence depended on the pH value and generally increased with decreasing pH. (tr-auth)

40160 (KR-126) REPROCESSING OF FUEL FROM PRESENT AND FUTURE POWER REACTORS. Advanced Course Organized by the Netherlands'-Norwegian Reactor School at Institut for Atomenergi, Norway, 21st August–1st September 1967. (Institutt for Atomenergi, Kjeller (Norway)). Sept. 1967. 532p. Dep.

These papers were presented at a course on fuel reprocessing and cover developments in the field from 1957 to 1967. Both the commercial and technical aspects of reprocessing are covered. Other aspects of the reprocessing field dealt with in these 31 papers are: economics of reprocessing and expected market development, technical aspects of reprocessing of fuels from present power reactors, Pu separation and reprocessing, waste problems, Th fuel cycle as an introduction to future power reactors, halide volatility processes, Aquafluor process, reprocessing of future fast breeder fuels, and safety aspects of reprocessing. Separate abstracts were prepared for each paper. (B.L.M.)

For abstracts of individual papers see: 39976, 39983, 39984, 40161–40187, and 42387.

40161 (KR-126, pp 9-20) COST OF REPROCESSING. Barendregt, T. J. (COMPRIMO, N. V., Amsterdam).

Costs of reprocessing fuels of the present reactor generation using aqueous methods are discussed. Fuels are of two types; U metal canned in Mg and U oxide canned in stainless steel or Zr alloy. Both initial costs as related to plant size and plant loading and running costs are considered. The annual operating costs at AEC, NFS, and Eurochemic are summarized and analyzed. It was concluded that for a 1 ton/day plant, capital charges, depreciation, and fee amount to nearly half the reprocessing costs, or $16/kg containing U. The running costs, including direct, overhead, and waste costs amount to $9/kg containing U. (B.L.M.)

40162 (KR-126, pp 21-30) HOW WILL THE REPROCESSING MARKET DEVELOP? Barendregt, T. J. (COMPRIMO, N. V., Amsterdam).

The amounts of fuels available today for reprocessing both in Europe and the USA are discussed. As the time between the decision to build a reactor and the first charge available for reprocessing is at least 6½ yr (time table included), rather accurate calculations of the reprocessing market for the year 1974 can be made. Estimates are made for the year 1980. The available reprocessing facilities in Europe today are 4 plants in operation and 2 under construction. The capacity of these are sufficient to cover the reprocessing needs for several years. In the USA only one commercial plant is in operation, although government-owned installations have a very high capacity. The

3 commercially operated reprocessing plants now in operation, Windscale-2, Nuclear Fuel Services, and Eurochemic are discussed briefly. (B.L.M.)

40163 (KR-126, pp 31-53) MECHANICAL FUEL HANDLING AND CHOP-LEACH PROCESSING OF NUCLEAR POWER FUELS. Reas, W. H. (General Electric Co., Santa Clara, Calif.).

Mechanical fuel handling and chop-leach methods, which are intended for use in General Electric's Midwest Fuel Recovery Plant, are discussed. The plant equipment designed to reprocess fuel elements that vary widely in geometrical configuration and cladding and structural material is discussed under the following headings: spent fuel receipt, cask decontamination and fuel unloading pit, mechanical cell, and fuel disassembly. In design of the fuel treatment systems, many commercial components of demonstrated performance and reliability are used along with some new equipment. The report includes 16 figures. (B.L.M.)

40164 (KR-126, pp 54-73) CHEMICAL DECANNING OF FUEL. Barendregt, T. J. (COMPRIMO, N. V., Amsterdam).

Various chemical decanning processes for fuel elements are discussed; NaOH dissolution of Al canning, boiling 4 M H_2SO_4 dissolution of stainless steel canning, boiling dilute H_2SO_4 dissolution of Mg and Mg alloy canning, and NH_4F solution dissolution of Zr and Zircaloy-2 canning. Two dissolvers presently in use at Eurochemic are described and pictured. The dissolvers are constructed of an alloy derived from "Ni-o-nel" called CS-M2. Several examples of chemical decanning are included. A brief discussion of the economics of chemical decanning is included. (B.L.M.)

40165 (KR-126, pp 74-96) FUEL DISSOLVING AND OFF-GAS TREATMENT. Barendregt, T. J. (COMPRIMO, N. V., Amsterdam).

The principles of U metal dissolution are described in detail and some comments are given on the practical aspects of the reaction. The chemical reaction and procedure for dissolution of U-Mo alloys and UO_2 in HNO_3 are discussed. In all the dissolution processes, NO and NO_2 are evolved, and it is necessary to add air and O_2 to the dissolvers to oxidize these oxides of nitrogen. The behavior of fission products present in the irradiated fissile material in the dissolution process and examples of fuel dissolution are discussed briefly. (B.L.M.)

40166 (KR-126, pp 87-100) FEED PRE-TREATMENTS IN AQUEOUS REPROCESSING. Kraak, W. (Reactor Centrum Nederland, Petten)

Treatments of aqueous HNO_3 feed solutions prior to solvent extraction processes are often necessary to remove finely divided SiO_2, nondissolved metal particles from alloyed fuels, or fission products that might also extract. Air purging at elevated temperatures may be necessary to remove I_2, I^-, and IO_3^-. The troublesome behavior of Ru in extraction processes is reviewed, as is the behavior of Zr and Nb. Oxidation as a means to reduce the problem of Ru is discussed, and oxidation by the formation in situ of MnO_2, which adsorbs Zr and Nb, results in a high rate of removal of Nb and Zr. The use of complexing agents for removal of Ru, Nb, and Zr is reviewed. Particularly for high-burnup fuels from fast reactors, highly efficient feed pretreatments can be important for the economy of the aqueous processing. (B.L.M.)

40167 (KR-126, pp 120-42) TBP EXTRACTION SYSTEMS. TBP AND DILUENT DEGRADATION. Naylor, A. (United Kingdom Atomic Energy Authority, Sellafield, Eng.).

Radiolytic and thermal decomposition of TBP and its effects on the extraction process and diluent degradation are discussed. The decomposition of the TBP in the presence of HNO_3 occurs by the radiolysis and thermal hydrolysis in both the organic and aqueous phases. Di-n-butyl phosphate (HDBP) forms complexes with U, Pu, and certain fission products with resulting retention of these in the organic phase to decrease the removal efficiency of the acid backwash for U and Pu. HDBP has short-term or single-pass effects on the process. Phosphoric acid, the final decomposition product of TBP especially produced in a highly active raffinate under conditions of evaporation and storage, can be present in quantities sufficient to limit evaporation factors and to even form precipitates of Zr, Cs, and other metals under these conditions. The composition of the diluent was shown to influence the amount of various TBP degradation products formed, and this finding indicates that aromatic compounds are preferable to aliphatics as diluents. A vast array of organic impurities are formed from the radiolytic degradation of the usual kerosene type diluent, and these degradation products have predominately long-term effects on the process. These effects from both degradation of the solvent and the diluent must be optimized by careful choices of diluent, residence time in the extraction equipment, and the solvent wash system. (B.L.M.)

40168 (KR-126, pp 172-200) PLUTONIUM-URANIUM SEPARATION TECHNIQUES IN TBP SYSTEMS. USE OF FERROUS SULPHAMATE, URANIUM(IV), AND AQUEOUS SOLUBLE COMPLEXING AGENTS. Naylor, A. (United Kingdom Atomic Energy Authority, Sellafield, Eng.).

In the development of a solvent-extraction method for separation of Pu and U, two general chemical principles were used to ensure transfer of the Pu into the aqueous phase while retaining the U in the organic phase: the use of a reducing agent to convert the extractable Pu(IV) to inextractable Pu(III), and the use of an aqueous soluble complexing agent that preferentially complexes with Pu(IV) to keep it in the aqueous phase. Various reducing agents were investigated, but ferrous sulfamate was the most satisfactory. Another reagent found to be competitive with ferrous sulfamate was uranous nitrate, and the theoretical aspects of its use as a reductant for the Pu(IV) are discussed: However, U(IV) undergoes more side reactions than does Fe(II). Both the preparation of uranous nitrate and pilot plant trials of its use as a possible reductant are discussed. Aqueous soluble complexing agents for Pu(IV) were investigated with SO_4^{-2} and PO_4^{-3} being found to be satisfactory. However, the conditions of separation must be carefully chosen and controlled. (B.L.M.)

40169 (KR-126, pp 201-28) AMINE EXTRACTION PROCESSES FOR PLUTONIUM SEPARATION. Hultgren, Ake V. (Aktiebolaget Atomenergi, Studsvik, Sweden).

A short summary of proposed applications of amine extraction to nuclear fuel reprocessing, especially to the separation and decontamination of Pu is given. The tertiary amines are discussed as Pu extractants with special consideration given to choice of diluent, extraction mechanism, backwashing techniques, selectivity, and radiation stability. Flow sheets are presented for Pu extraction by amines, and the separation of Pu from irradiated U is discussed in detail. (36 references) (B.L.M.)

40170 (KR-126, pp 229-44) PLUTONIUM PURIFICATION BY ION EXCHANGE. Kraak, W. (Reactor Centrum Nederland, Petten).

Use of either cation or anion exchange resins or a combination of the two for removal of residual impurities from the Pu resulting from a solvent extraction process is discussed. A cation exchange resin absorbs all 3 Pu valency states from dilute HCl or HNO_3 solutions. However, if Pu is kept in the trivalent state, the desorption coefficient is higher, and a more concentrated product is obtained. If both cation and anion exchangers are used, better separation from Zr and Nb is obtained. Anion exchange separation of Pu is both chemically and mechanically simpler than cation exchange separation and offers an easy possibility of purifying Pu. In the anion exchange separation an increase in temperature increases the concentration of both the throughput and final product. Pu remains in the tetravalent state throughout, and no chemicals other than HNO_3 are involved. Decontamination factors of 5×10^3 for fission products and 5×10^4 for U are obtained with a final product concentration of 50g of Pu/l in a single cycle with an anion exchanger. (B.L.M.)

40171 (KR-126, pp 245-66) TREATMENT AND DISPOSAL OF EFFLUENTS. Hardwick, W. H. (Atomic Energy Research Establishment, Harwell, Eng.).

Treatment of low and intermediate wastes arising from separation plants is discussed briefly. Low-level wastes can be dispersed into the environment or they can be concentrated and stored. These low-level wastes can be concentrated by floc treatment, ion exchange, or solidification. The treatment of high-level wastes poses a greater problem of concentration and disposal. Concentration and storage of high-level wastes are accompanied by and complicated by the decay heat, which must be removed. Tank installations for liquid storage at Windscale, Hanford, and Savannah River are described. As an alternative to storage of high-level liquid wastes, fixation methods in the USA at Idaho Falls, ORNL, and Brookhaven; in the UK; in France; and in Russia are described briefly. Note is taken of the accompanying processing hazards. (B.L.M.)

40172 (KR-126, pp 267-78) RECOVERY OF BYPRODUCTS. Hardwick, W. H. (Atomic Energy Research Establishment, Harwell, Eng.).

Attention is being given to recovery of stable elements and radiation and heat sources from reprocessing wastes. Stable elements that could be recovered from the wastes are ^{103}Rh, xenon, and ^{99}Tc. The isotopes usable as radiation sources include ^{85}Kr, ^{144}Cs, ^{144}Pr, ^{137}Cs, and ^{137}Ba, and as heat sources include ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{241}Am, ^{242}Cm, ^{244}Cm, and ^{238}Pa. Processes for separation of fission products and transuranic elements are described with particular reference to current wastes from Purex operations from which ^{137}Cs, ^{90}Sr, and rare earths are separated and to aged self-boiling wastes consisting of alkaline supernate

and sludge. Cesium-137 and ^{99}Tc are removed from the supernate while the sludge yields ^{90}Sr, rare earths, Np, Pu, U, and small amounts of ^{137}Cs. Several methods are suggested for the separation of Cs from wastes and of ^{85}Kr from the offgases from dissolver plants. (B.L.M.)

40173 (KR-126, pp 298-323) REPROCESSING OF THORIUM FUELS. Roberts, J. T. (Oak Ridge National Lab., Tenn.).

Aqueous chemical reprocessing of Th-bearing spent fuels from nuclear reactors is reviewed. The discussion is limited to fuels of the most promising reactor types. Emphasis is placed on the differences in reprocessing methods and costs between these Th fuels and the standard low-enrichment U metal or oxide fuels clad in Al, Zr, or stainless steel. Head-end processes, starting with irradiated fuel elements and ending with a nitrate solution suitable for feed to solvent extraction equipment are described for various fuel types. Flow sheets for various solvent extraction processes are evaluated. (56 references) (B.L.M.)

40174 (KR-126, pp 324-41) REVIEW OF HALIDE VOLATILITY PROCESSES. Schmets, J. J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.).

A halide (particularly fluoride) volatility process for recovery of U and Pu from irradiated fuel elements includes the following steps: chemical, mechanical, or pyrometallurgical decladding; fuel pulverization; fluorination by an interhalogen compound followed by F_2 or, as an alternative, by F_2 alone; UF_6 and PuF_6 collection; UF_6 and PuF_6 purification; UF_6 and PuF_6 conversion into oxides or other fuel materials, regeneration, purification, and recycling of reagents; and treatment of wastes. Presently the main effort in fluoride volatility processes is based on fluid beds, such as alumina, but other techniques are being investigated. Certain liquid-phase processes using interhalogen compounds and a process using anhydrous HF and a complexing agent capable of forming nitrosyl ions are reviewed briefly. Melts of inorganic fluorides can also be used to dissolve fuels. (B.L.M.)

40175 (KR-126, pp 342-60) FLUORIDE VOLATILITY PROCESSES. APPLICATION TO COMMERCIAL NUCLEAR FUEL RECOVERY. Reas, W. H. (General Electric Co., Santa Clara, Calif.).

Application of the fluoride volatility processes to low-enrichment ($\leq 5\%$ ^{235}U) oxide fuels for commercial light water reactors is considered. The fluoride volatility processes considered are: initial volatilization of UF_6 and PuF_6 by elemental F_2, selective fluorination of U_3O_8 by an interhalogen fluorinating agent followed by conversion of PuO_2 to PuF_6 using elemental F_2, and three aqueous-fluoride volatility hybrid processes in which Pu is recovered by aqueous processing techniques. These processes are appraised from several different points; such as plant U input, products recovery capability, maintenance of fuel batch integrity, etc. Several distinct deficiencies relative to the service requirements render these fluoride volatility processes not suitable for commercial application until the deficiencies are fully resolved and are in reasonable balance with the overall business risk. (B.L.M.)

40176 (KR-126, pp 361-84) AQUAFLUOR PROCESS. Reas, W. H. (General Electric Co., Santa Clara, Calif.).

The aquafluor process for use in the Midwest Fuel Recovery Plant and a description, with figures, of the plant are presented in some detail. The as-received fuel is mechanically disassembled, and the rods are sheared into short lengths and fed into a dissolver. The fuel, containing Pu, Np, and fission products, as well as unspent U, is dissolved in hot HNO_3. A single solvent-extraction cycle of the Purex type separates the fuel constitutents from the fission products. Recovery and final decontamination of the Pu and Np are accomplished by anion exchange, after which the products are routed to load-out facilities in the form of nitrate solutions. The U process stream stemming from the ion-exchange operation is fed to an intercycle concentrator to form a uranyl nitrate hexahydrate solution for subsequent calcination operation. The hexahydrate conversion to UO_3 is accomplished by means of a fluidized-bed calciner. The UO_3 is reacted with F_2 in a fluidized-bed fluorinator to form UF_6. This gaseous UF_6 is passed through NaF and MgF_2 beds followed by distillation of liquid UF_6 to remove traces of Pu, Np, and certain fission products. Procedures for all waste processing associated with the process are described. (B.L.M.)

40177 (KR-126, pp 385-93) FAST BREEDER REACTOR FUEL CYCLES. Steunenberg, R. K. (Argonne National Lab., Ill.).

Some prediction is made concerning the future development of fast breeder reactors and resulting fuel reprocessing loads. Of the proposed fast breeder reactors, those fueled with oxides will likely constitute the first generation of central station fast breeder reactors. An illustrated fuel processing cycle based on U-Pu system is presented. Even though the same basic separation of U, Pu, and fission products is involved that is encountered in processing of thermal fuels, many other problems to be solved are discussed. Additional development work will be necessary to adapt aqueous and fluoride volatility methods to the breeder fuels. Pyrochemical processes now being developed should be useful. (B.L.M.)

40178 (KR-126, pp 394-404) REPROCESSING OF FAST BREEDER FUELS BY AQUEOUS METHODS. PART 1. REPROCESSING OF FUEL FROM DOUNREAY FAST REACTOR. Allardice, R. H. (United Kingdom Atomic Energy Authority, Caithness, Scotland).

The U-Mo fuel elements from the Dounreay Fast Reactor are mechanically decanned, dissolved batchwise in HNO_3 (56 g/l) in a Ti vessel with Fe present to complex the Mo and prevent precipitation of U-Mo complexes, and extracted with 3 cycles of TBP. Separate discussions are presented on the efficiency of the process on elements cooled for different periods of time, the behavior of ^{131}I in the process, the effects of high activity feeds on the process, decontamination factors, and solvent quality. (B.L.M.)

40179 (KR-126, pp 405-14) REPROCESSING OF FAST BREEDER FUELS BY AQUEOUS METHODS. PART 2. SECOND AND THIRD GENERATION FAST REACTORS. Allardice, R. H. (United Kingdom Atomic Energy Authority, Caithness, Scotland).

No large reprocessing requirements for fast reactor fuels are anticipated before 1980, so presently aqueous reprocessing of fuels is considered adequate for fuels for the second and early third generation reactors, i.e., mixed U-Pu oxides clad in stainless steel. Two of the main problems will be the continuous removal of heat during all operations of the subassembly and the long plant cooling time before transport to a separate processing plant can be made. However, studies carried out in the UK indicate that current solvent extraction processes are capable of reprocessing fast reactor fuel in existing thermal reactor fuel reprocessing equipment either diluted with thermal reactor irradiated fuel or using a dilute flow sheet. A single line of geometrically safe equipment using a currently conventional 20% TBP flow sheet could handle the fuel produced from a 12,000 MW(e) fast reactor. (B.L.M.)

40180 (KR-126, pp 415-24) FAST CONTACTORS. A REVIEW OF TWO SOLVENT EXTRACTION DEVICES DEVELOPED IN THE UNITED STATES. Klitgaard, J. (Danish Atomic Energy Commission, Risoe).

Two fast contactors for reprocessing of high-burnup fuels are described and illustrated. A multistage centrifugal contactor was developed at Savannah River Laboratory and is already in use there. A stacked-clone contactor is being developed at Oak Ridge National Laboratory. (B.L.M.)

40181 (KR-126, pp 425-51) FLUORIDE VOLATILITY PROCESSING OF FAST BREEDER FUELS. Schmets, J. J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.).

A review of the chemistry and technology of processes using ClF_3 and ClF for regenerate fast breeder fuels is presented. A typical flow sheet for the fluoride volatility process is included, and each of the process steps is described. The kinetics of the reactions involved in the process are reviewed. From present results reported on Pu fuels, it is believed that the proposed fluoride volatility process will be particularly adaptable to high-burnup fast breeder fuels. Various $\alpha-\gamma$ scaling up facilities are presently installed at CEN Laboratories for further experimentation. (B.L.M.)

40182 (KR-126, pp 452-67) PYROMETALLURGICAL PROCESSING OF FAST BREEDER FUEL. Steunenberg, R. K. (Argonne National Lab., Ill.).

Two pyrometallurgical techniques, use of Zn-Mg alloy as a liquid metal solvent for separation of Pu and U and a halide slagging method, are mentioned for use in reprocessing fast breeder reactor fuels. The closed, on-site fuel cycle for remote reprocessing of fuels at EBR-II complex located at the National Testing Station located in Idaho is described, as is the reactor. A melt refining process using ZrO_2 crucibles and a skull reclamation process are described. Some development work is reported on a liquid metal solution process for the recovery of Pu from metallic U as a method for processing the EBR-II blanket should the need arise. (B.L.M.)

40183 (KR-126, pp 468-75) VARIOUS APPROACHES TO DRY REPROCESSING. Schmets, J. J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.).

Some selected processes for dry reprocessing of fuels in view of future applications are summarized. Molten salt techniques are discussed as a method for reprocessing fuels from thermal heterogeneous reactors or as a final conversion step coupled with

a fluoride volatility process to produce the oxides from the UF_6 and PuF_6 resulting from the fluoride volatility process. A process for thermal decladding of stainless steel-clad oxide type fuel elements is mentioned, as is the AIROX pyrochemical process. (B.L.M.)

40184 (KR-126, pp 476-93) SALT TRANSPORT PROCESSES FOR CERAMIC FAST BREEDER FUELS. Steunenberg, R. K. (Argonne National Lab., Ill.).

The salt transport process is expected to handle both core and blanket material of fast breeder reactors either together or separately and is being developed primarily for oxide fuels but with relatively minor modifications could be adapted to carbide or metallic fuels. The fuel is declad by selective dissolution of the stainless steel in Zn at 800°C followed by a separation of the oxide fuel from the waste Zn solution. The oxides mixture is added to a molten salt mixture, which is contacted under agitation with a liquid Cu–33 wt % Mg alloy to reduce the oxides to metallic U and Pu. The alkali metal, alkaline earth, and rare earth fission products, and solid MgO remain in the waste salt. Kr, Xe, and possibly some I_2 are collected in the Ar cover gas. The U appears in the alloy phase as a precipitate, and the Pu remains in the alloy solution. A molten chloride salt is cycled between the Cu–Mg alloy (donor) and a Zn–5 wt % Mg alloy (acceptor) to extract Pu away from the U and fission products. The Pu is removed from the acceptor alloy as a metallic product by vacuum distillation. The precipitated U is removed from the Cu–Mg alloy by decantation and washing with liquid Mg to remove residual Cu and fission products. The process is expected to provide Pu and U recoveries of at least 99% and fission products decontamination factors of 10^3 to 10^4. The basic chemistry of the process steps is reasonably well understood, and the development work is largely in the early engineering stages. (B.L.M.)

40185 (KR-126, pp 494-504) SAFETY ASPECTS OF AQUEOUS REPROCESSING. Allardice, R. H. (United Kingdom Atomic Energy Authority, Caithness, Scotland).

The safety aspects of each separate step in an aqueous reprocessing method are considered. Heat dissipation so necessary during fuel transport to prevent rupture of the cladding material is best provided for by transporting the subassembly in a He-filled flask. Good operational procedures take care of radiation hazards during storage prior to processing. The head-end dissolution process gives rise to at least 3 separate points of safety concern. Back-up procedures for the personnel operating the plant and process are discussed. Various aspects of the criticality hazards and criticality control are discussed in some detail. (B.L.M.)

40186 (KR-126, pp 505-18) SAFETY ASPECTS OF NONAQUEOUS REPROCESSING. Schmets, J. J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.).

Safety problems in a plant using a fluoride volatility process for fuel reprocessing include those in an aqueous reprocessing plant plus the problems resulting from the use of fluorides and those associated with the volatile fluorides of U, Pu, Np, and fission products. The powder forms of radioactive material present raise contamination and criticality problems, and the neutrons produced by the (α,n) reaction require special shielding at the tail-end of the process. A tentative list of points of interest is made with reference to pyrochemical or pyrometallurgical processes. (B.L.M.)

40187 (KR-126, pp 519-32) TECHNICAL AND ECONOMIC EVALUATION OF AQUEOUS AND NONAQUEOUS REPROCESSING. Roberts, J. T. (Oak Ridge National Lab., Tenn.).

Some of the factors influencing the choice of which reprocessing method is best suited to what use are considered. It was concluded that no one method can be considered best at present for all applications or for future applications. The present status of the aqueous and nonaqueous reprocessing development is tabulated. Methods of economic evaluation of spent-fuel reprocessing costs in the overall context of the nuclear power cost evaluation are discussed. The processing costs in $/kg for selected values of backlogging and plant size are tabulated. (B.L.M.)

40188 (KR-128) LONG-CHAIN ALKYLAMMONIUM NITRATES AS EXTRACTING AGENTS FOR Pu(IV) NITRATE. Bae, R. (Institutt for Atomenergi, Kjeller (Norway)). May 1968. 127p. Dep.

The extraction of trace amounts of Pu(IV) from aqueous, usually 0.5 or 3 molar, nitric acid solutions by organic quaternary ammonium nitrates of a high molecular weight was studied. o-Xylene and n-dodecane, sometimes modified with a few volume per cent of octanol, were mainly used as diluents. Several commercially available long-chain quaternary ammonium compounds were compared with respect to their purity and physical behavior as extractant. Acceptable metal extraction performance was displayed by quaternary ammonium nitrates that have at least two large hydrocarbon substituents. As representatives of these types the extracting agents trilaurylmethylammonium nitrate (TLMA) and hexadecyldimethylbenzylammonium nitrate (HDDMBA) were selected for detailed extraction studies. It was established that formation of the definite complexes QO and QO_4 between the long-chain ammonium extracting agent (Q) and various octanol (O) species in o-xylene and the complex QO_3 in n-dodecane offers a quantitative explanation of the decrease in Pu(IV) distribution coefficient due to octanol. Mixtures of two long-chain ammonium nitrates were also used. In this case the net Pu(IV) distribution coefficient, D, in octanol containing o-xylene and n-dodecane was usually larger than the sum of the Pu(IV) distribution coefficients, $D_A + D_B$, using the components as single extracting agents. Experimental values of D agree with the theoretical value of the distribution coefficient that was derived by assuming the formation of the complexes MA_2, MB_2, and MAB, where M represents Pu(IV) nitrate, in the organic phase. The influence of the aqueous nitric acid concentration on the metal extraction is discussed and an explanation is given for the position of the maximum Pu(IV) distribution coefficient as a function of the aqueous acidity. It appeared that chemical degradation of the extracting agent is completed earlier with increased acid concentration and further that a quaternary ammonium nitrate is less susceptible to chemical attack than a tertiary nitrate. Saturation of benzene solutions of various quaternary ammonium nitrates with thorium nitrate as stand-in for Pu(IV) reveal values for the concentration ratio extracting agent to metal ion, slightly above the theoretical value of 2. These values occur with a homogeneous organic phase as well from both the light and heavy organic phase in case of separation of the extractant. (auth)

40189 (NP-17542) PILOT SCALE STUDIES ON DISSOLUTION PROCESSES FOR NUCLEAR FUELS. II. ALUMINUM, MAGNESIUM, STAINLESS STEEL DECANNING, AND NONIRRADIATED URANIUM METAL DISSOLUTION TESTS IN A PILOT RECIRCULATION DISSOLVER. Hasler, A.; Centeno, J.; Marchant, Y.; Van Eylen, R. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Sept. 1967. 82p. (ETR-207). Dep.

A detailed description of a half-scale pilot dissolver is given. The results of four series of runs including aluminum, magnesium, and stainless steel decladding and dissolution of nonirradiated uranium metal are summarized and discussed. The reaction rates measured in the pilot dissolver and those obtained in laboratory equipment were in agreement. Means for instantaneous measurement of the reaction rate were demonstrated successfully. Uranium metal dissolution with independent recovery of nitric acid and recycling of the recovered nitric acid to the dissolver was carried out and the suitability of automatic O_2 supply control systems for oxidizing NO are discussed. Some border problems connected with the operation of a dissolution unit, i.e., corrosion, liquid circulation, reaction control, and prevention of explosion risk are also considered. The general conclusion was, that for similar development work, the use of large-scale equipment constructed in expensive stainless steel can be avoided and that enough information could be provided by using a very simplified full-scale pilot unit constructed in cheap material and simulated fuel materials and dissolution reagents that do not cause severe corrosion. (auth)

40190 (ORNL-tr-1950) ISOTOPIC CHROMATOGRAPHY. Jousselin, C.; Massot, C. (Societe Nationale des Petroles d'Aquitaine, Paris (France)). Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from a French report. 134p. Dep. CFSTI.

Calculations that describe experimental results in elution chromatography are presented. It is shown that chromatography increases the enrichment obtained by simple adsorption according to the basic relation: $\rho^* = R\,(\Delta A/A)$, where ρ^* is the chromatographic enrichment factor and R is the resolving power of the column. Quantitative chemical calculations are presented, which allow evaluation of the relative difference in the adsorption coefficients in simple cases. The exact numerical solution of the general problem is given. (M.C.G.)

40191 KHIMICHESKAYA TEKHNOLOGIYA REDKOMETAL'NOGO SYR'YA. (Chemical Technology of Rare Metal Ores). Motov, D. L. (ed.). Moscow, Izdatel'stvo Nauka, 1966. 116p.

Seventeen articles are included of the treatment of complex zirconium silicate (evdialyte). Reduction of evdialyte by weak sulfuric acid, separation of zirconium from solutions, and zirconium separation from impurities are discussed in the first three articles. Treatment of rare earth titanium niobates, separation of Nb and Ti by cyclohexanone and concentration of hydroxides are covered in the next four chapters. Separation and concentration of Ce using organic solvents and tributyl phosphate, extraction of La, Pr, and Nd by oxygen-containing

organic solvents, separation of La, Pr, and Nd by cyclohexanone, and separation of rare earth nitrates by tributyl phosphate extraction are described in the next seven chapters. The last three chapters deal with kinetics of pollucite reaction with potassium oxide and ferrosilite and with the preparation of high-purity Ta powder from tantalum pentoxide, separated by cyclohexanone extraction. (R.V.J.)

40192 ADSORPTION BEHAVIOR OF A NUMBER OF METALS IN HYDROCHLORIC ACID ON A WEAKLY BASIC ANION EXCHANGE RESIN. Kuroda, Rokuro; Ishida, Koji; Kiriyama, Tetsuya (Univ. of Chiba, Japan). Anal. Chem., 40: 1502-6(Aug. 1968).

The distribution coefficients for some 40 elements in a hydrochloric acid medium were studied using a weakly basic phenol condensation type resin, Amberlite CG4B at an acid concentration range of mostly 1 to 9M. The anion exchange with Amberlite CG4B makes it possible to effect some separations like the rare earths–Th, Te(IV)–Bi(III), Sn(IV)–Sb(III), which are difficult with a strongly basic anion exchange resin in pure aqueous hydrochloric acid solutions. The results on 32 two-component separations are presented and 4 multicomponent elution profile curves are illustrated to demonstrate the utilization of distribution coefficient measurements for separations. (auth)

40193 NATURE OF THE COMPLEX EXCHANGE PROCESS IN RARE EARTH ELUTIONS WITH LACTATE AND α-HYDROXYISOBUTYRATE. Powell, J. E. (Iowa State Univ., Ames). J. Inorg. Nucl. Chem., 30: 1331-4(June 1968).

For the cation exchange separation of lanthanide rare earths buffered salt solutions of lactic acid and α-hydroxyisobutyric acid are commonly employed as eluants. A review is presented on species formed, separation factors, activity coefficients, etc. Some criticism of earlier work is made. (U.K.)

40194 HEAVY WATER PRODUCTION [IN CANADA]. Law, C. A. Nucl. Eng., 13: 510-12(June 1968).

Canadian heavy water requirements are considered, and the production program based on the Deuterium of Canada and Canadian General Electric plants at Cape Breton is discussed. Studies are reported for the improvement of the GS(H_2O/H_2S) process used in these plants, and for the development of the NH_3/H_2 system. (UK)

40195 DEUTERIUM CONCENTRATION PROCESSES. Kenyon, Albert Raymond (to United Kingdom Atomic Energy Authority). U. S. Patent 3,377,135. Apr. 9, 1968. Priority date Feb. 4, 1960, Great Britain.

A process for D concentration comprises contacting gaseous H_2 with a liquid NH_3 medium made up of liquid NH_3 and an amine selected from the group consisting of methylamine, dimethylamine, diethylamine, pyrrolidine, and its alkyl-substituted derivatives, and piperidine and its alkyl-substituted derivatives. Potassamide is added to the liquid medium to catalyze the exchange. (Offic. Gaz.)

40196 SEPARATION OF URANIUM(IV) FROM RARE EARTH (III) BY HYDROLYTIC PRECIPITATION. Tomazic, B.; Branica, M. (Inst. Ruder Boskovic, Zagreb). Inorg. Nucl. Chem. Lett., 4: 377-80(July 1968).

Data are given from which the conclusion is drawn that for successful separation of U from rare earth fission products in nitrate solutions by hydrolytic precipitation of U(VI) the pH should not exceed a critical value of 4.5. Hydroxide (KOH or NH_4OH) to uranium ratio must be strictly controlled. Under these conditions 90% U recovery can be achieved in one operation. The remainder can be recovered by concentration of the mother liquor and repetition of the precipitation process. Three-fold washing of precipitates with neutral electrolyte (KNO_3 or NH_4NO_3) resulted in very efficient desorption of co-precipitated or adsorbed rare earths. (UK)

40197 EUREX FUEL REPROCESSING PLANT NEARS COMPLETION. Nucl. Eng., 13: 590-2(July 1968).

The main functions of the pilot plant built by CNEN at Saluggia, Italy, are discussed. Attention is drawn to its high adaptability, which enables its use for a variety of fuels. Problems encountered during building are discussed. Brief details of process equipment, and a description of the instrumentation, are given. A cost breakdown is included. (UK)

40198 EXTRACTION OF PROTACTINIUM FROM MINERAL ACID–ALCOHOL MEDIA. Alian, A.; Sanad, W.; Shabana, R. (Atomic Energy Establishment, Cairo). Talanta, 15: 639-51 (July 1968).

The extraction of protactinium with organic solvents was investigated in the presence of water-miscible alcohols and acetone. These additives increased considerably the extraction with trilaurylamine, tributyl phosphate, and isobutyl methyl ketone. The influence was less in the case of thenoyltrifluoroacetone. In mixtures of an acid with various alcohols, the influence depended on the alcohol concentration, the acidity, and on the chain length and dielectric constant of the alcohol introduced into the extraction system. (auth) (UK)

40199 SEPARATION OF CARRIER-FREE SILVER FROM NEUTRON-IRRADIATED PALLADIUM. Lyle, S. J.; Maghzian, R. (Univ. of Kent, Canterbury, Eng.). Talanta, 15: 712-13(July 1968).

The use of a chelate-forming ion-exchange resin for separation of carrier-free ^{111}Ag from neutron-irradiated palladium is described. (auth) (UK)

40200 TRITIUM ENRICHMENT BY GAS-SOLID CHROMATOGRAPHY: TECHNIQUE FOR LOW-LEVEL ANALYSIS. Hoy, John E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Science, 161: 464-5(Aug. 2, 1968). (DP-MS-68-17).

A palladium chromatograph was developed that can detect less than 10 atoms of tritium per 10^{18} atoms of hydrogen. Columns operated at ambient temperature have 70-liter hydrogen capacity (50-milliliter water sample) and give 60 percent recovery in the first 500 cubic centimeters of gas evolved. (auth)

40201 RADIOCHEMICAL APPLICATION OF "IRON FERROCYANIDE–ANION EXCHANGE RESIN." Watari, Kazuo; Imai, Kiyoko; Izawa, Masami (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 309-12(June 1968).

Preparation of iron ferrocyanide anion exchange resin and adsorption of ^{137}Cs on the resin are described. The resin was found to effectively adsorb ^{137}Cs from concentrated nitric acid solution, contrast to the negative results previously obtained with copper ferrocyanide anion exchange resin. A discussion is given of the possibility of applying the iron resin to the removal of ^{137}Cs from fuel reprocessing waste solution. Fission products were effectively separated from each other with a column of this resin, utilizing the properties possessed by it of both iron ferrocyanide and the parent ion exchange resin. (auth)

40202 IMPROVEMENT OF CHEMICAL SEPARATIONS ON ION-EXCHANGE RESINS: INFLUENCE OF GRANULOMETRY. Aubouin, G.; Laverlochere, J. (CEN, Grenoble, France). J. Radioanal. Chem., 1: 123-37(Mar. 1968). (In French).

In order to reduce the time requirement for ion-exchange separations the kinetics of the elution of different ions were studied as a function of the grain size of the ion-exchange resins. Using a countercurrent apparatus seven different fractions could be separated using Dowex 1 × 10 and 50 W × 12. Grain size had a great influence on the shape of the elution curves. The finer and more homogeneous the resins, the sharper are the peaks on the elution curves. These considerations were utilized for the separation of rare earths, alkali metals, and alkaline earth metals, respectively. (auth)

40203 RAPID SEPARATION OF RADIOACTIVE ELEMENTS BY EVAPORATION IN VACUUM. Gasior, Marian; Lizurej, Henryk I.; Niewodniczanski, Henryk; Potempa, Antoni W. (Inst. of Nuclear Physics, Krakow. Univ., Krakow). Nukleonika, 13: 635-43(1968). (In Polish).

An apparatus and techniques are described for the rapid separation of radioactive elements from the target material irradiated in a cyclotron. In order to choose the most suitable conditions for separation a graph of the temperature dependence of the saturated vapor pressure of many elements is given. Some examples of the application of this method are also given. (auth)

40204 INVESTIGATION OF THE SORPTION PROPERTIES OF AMBERLITE ^{120}Ir AND OF AMORPHOUS ZIRCONIUM(IV) PHOSPHATE FOR THE SEPARATION OF URANIUM FROM MIXTURES. Pekarek, V.; Maryska, S. (Institut fuer Kernforschung, Rez, Czech. Staatliches Forschungsinstitut fuer Textilien, Brno). Collect. Czech. Chem. Commun., 33: 1612-16(May 1968). (In German).

The mutual separation of uranium, vanadium, tungsten, and molybdenum on the cation exchanger Amberlite IR-120 and the separation of a series of uranium cations on the same ion exchanger from 1N $HClO_4$ was described. The results were compared with the sorptive properties of amorphous zirconium(IV) phosphate. (tr-auth)

40205 GENERAL RELATION BETWEEN FORWARD AND BACKWARD ISOTOPE SEPARATION FACTORS IN THE HYDROGEN ELECTRODE REACTION. Yokoyama, Takamitsu; Enyo, Michio (Hokkaido Univ., Sapporo). J. Res. Inst. Catal., Hokkaido Univ., 15: 207-17(1967).

A general relation was derived between two electrolytic hydrogen-deuterium separation factors, S_f and S_b, respectively, in the hydrogen evolution and ionization reactions on an electrode in the system composed of "light" water (containing deuterium of the

natural abundance) and hydrogen gas at any deuterium atomic fraction X^G. The relation was found to depend on the value of ν, the stoichiometric number of the rate-determining step of the hydrogen electrode reaction. In the case of $\nu = 1$, S_f is given as $S_f = Q_{L-G,0} \cdot \sigma_{23}$ at any X^G value, where $Q_{L-G,0}$ is the partition coefficient of deuterium between aqueous solution and hydrogen gas at $X^G \simeq 0$ and σ_{23} is the ratio of specific rate of ionization of H_2 to that of HD; the latter is determined from S_b. In the case of $\nu = 2$, the relation is $S_f = Q_{L-G,0} \cdot S_b(m^{HD}/2m^{H_2})(1-X^G)/X^G$, where m is the mole fraction of the species specified. The former relation was applied to several systems, all of which are known to belong to the case $\nu = 1$. From S_b obtained by measuring the isotopic mixed potential of the hydrogen electrode in the system composed of light water and deuterium-containing hydrogen, the following S_f-values were obtained at 25°C: 3.9 for Au in 1N H_2SO_4, 4.2 for Pt, and 6.2 for Ni both in 0.1 N NaOH solution. (auth)

40206 MODERN METHODS OF SEPARATING ZIRCONIUM AND HAFNIUM. Vinarov, I. V. (Inst. of General and Inorganic Chemistry, Kiev). Russ. Chem. Rev. (Engl. Transl.), 36: 522-36(July 1967).

In the introduction to this review (with 192 references), historical perspectives are drawn on the uses of the pure metals. Methods of separating Zr and Hf are discussed, including fractional crystallization, fractional precipitation, fractional distillation, selective dechlorination of $ZrCl_4$, selective reduction of the tetrachlorides by metals, electrolysis of melts, adsorption and ion exchange, and selective extraction by solvents. Future prospects for the application of the most important methods for separating Zr and Hf are discussed. Almost all methods of fractional crystallization or precipitation are rejected for industrial use because of the low separation factors and the tedious and time-consuming nature of the technological processes, as are the inefficient methods of selective dechlorination and electrolysis. The method of selective reduction of the chlorides by metals is of considerable interest, since it uses chlorides, obtained from zircon by the efficient chlorination method, and eliminates completely the intermediate hydrometallurgical stages in the production of Zr and Hf. Of the ion-exchange methods, cation exchange on the sulfonic acid cation-exchange resins Dowex-50, KU-2, etc. has found most extensive application, because of the high separation factors, the availability of the resins and reagents used, and the possibility of setting up a continuous countercurrent process. At present, however, the most promising field of application of the ion-exchange method for the separation of Zr and Hf is evidently to be found in the treatment of high-percentage Hf concentrates and the refining of Hf and Zr specimens. The methods of selective extraction by solvents, particularly IBMK and TBP, are widely used in industry. One of the most important tasks facing industries producing pure Zr and Hf must be the further improvement of the technology of extraction separation processes, including the search for the most readily available and at the same time highly efficient complex-forming reagents and extracting agents. (BBB)

40207 LOHMEN CENTRE FOR THE TREATMENT AND DISPOSAL OF RADIOACTIVE WASTES OF THE STATE CENTRE OF RADIOLOGICAL PROTECTION. Richter, D. (Staatliche Zentrale fuer Strahlenschutz, Pirna, Ger.). Isotopenpraxis, 4: 32-4(Jan. 1968). (In German).

The methods and techniques used at the Lohmen Center for the treatment and disposal of radioactive wastes are briefly described. The collection and transportation facilities for transferring the waste materials to the processing center are illustrated. (J.S.R.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 40258, 40281, 40431, 40477, and 40516.

40208 (BNWL-835) RADIOLOGICAL STATUS OF THE GROUND WATER BENEATH THE HANFORD PROJECT, JULY-DECEMBER 1967. Essig, T. H. (Battelle-Northwest, Rcihichland, Wash. Pacific Northwest Lab.). June 5, 1968. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

Over 500 wells are used for the surveillance of radionuclides in the ground water. Total beta concentrations in the unconfined and confined ground water aquifers are tabulated. Results are tabulated for well water samples in which beta concentrations exceed the analytical limit and comparisons noted for previous reporting periods. Ground water samples near the 200-Area are analyzed for total beta, tritium, and nitrate. Other routine groundwater analyses include total alpha, strontium-90, cesium-137, and cobalt-60. Ruthenium-106 and tritium concentrations are present beneath the Hanford Project and are represented on maps. (J.C.W.)

40209 (SC-RR-68-196) NATURAL BACKGROUND RADIATION LEVELS IN FLORIDA. Golden, J. C. Jr. (Sandia Corp., Albuquerque, N. Mex.). May 1968. 32p. Dep. CFSTI.

Measurements of external gamma radiation and radioactivity in air, food, and water have shown that the region encompassed by the Bone Valley phosphate deposit in Central Florida has a higher background radiation level than the remainder of the state. However, additional work—such as quantitative/qualitative analyses of radioactivity in food and water—must be done before any estimate of total radiation exposure may be made. (auth)

40210 DEPENDENCE OF THE NATURAL RADIOACTIVITY OF THE GROUND AIR ON THE TEMPERATURE INVERSIONS IN THE ATMOSPHERE. Teneva, Marinka; Manolov, Ljudmil. Izv. Inst. Khidrol. Meteorol., Bulg. Akad. Nauk, 9: 19-30(1966). (In Russian).

The influence of temperature inversions on the natural radioactivity of the ground layer of air over the Sofia Plain is examined for a period of three years (1961 to 1963). It was established that the concentration of the natural radioactivity of the ground layer shows an increase during ground inversions, compared with the cases of intensified vertical turbulent exchange. In the case of higher inversions it is smaller than under conditions of normal distribution of the temperature. The temperature gradient and the thickness of the ground inversions affect the change in the natural radioactivity of the ground layer. In general, the ground inversions operate as a type of obtruding layer to the spread of the natural radioactivity of the ground layer in altitude. (Abstr. Bulg. Sci. Lit.)

40211 NATURAL RADIOACTIVITY OF BULGARIAN SOILS. Raikov, L. (Soil Research Inst., Sofia). Rast. Nauki, 2: 31-6 (1965). (In Russian).

Total β-radioactivity of various soil types and paternal rocks was measured by means of a STS-6 counter. Measurements were made with two cylinders—outside and inside one. A tritiated soil sample of 150 g, shifted through 1 mm mesh sieve, was put in the outside cylinder and in the inside cylinder, the wall of which is a thin paper, and placed the cylindrical counter. Radioactivity of various soils is expressed in impulses per minute and it varies greatly. Cinnamon forest soils, developed over calcareous rocks, have a radioactivity of about ten impulses per minute, while the radioactivity of brown forest soils, underlain with rhyolites and alluvial and diluvial soils developed over materials originating in acid eruptive rocks attains ten times higher values. Chernozem soils, grey forest, chernozem–smolnitza and podzolic cinnamon soils take a medium position within the extremes pointed out. The radioactivity of nearly all soils investigated was due (in two thirds of the cases) to radioactive potassium. Uranium, thorium and other element groups have a greater participation in the peat-bog and solonetz soils in the region of Plovdiv. Considerably increased radioactivity (2 to 3 times) of the 0 to 6 cm top soil layer was observed in virgin soils of certain mountain areas due to radioactive elements deposited by precipitation. (auth)

40212 DEUTERIUM CONTENT IN NATURAL WATERS. Molochnova, V. A.; Sokolov, M. M.; Gorev, A. V.; Bugrov, N. M. (All-Union Inst. of Applied Geophysics, Leningrad). Geochem. Int. (Engl. Transl.), 4: 484-9(1967).

Deuterium contents of 130 samples of natural waters from a Precambrian crystalline terrane (Ukrainian shield) and from a Paleozoic volcanic-sedimentary terrane (Central Kazakhstan) are closely clustered about a mean value of 0.0148 ± 0.0003 mol. percent D_2O. D_2O contents of ground waters (aquifers, pore and fissure waters) tend to increase with depth but do not differ significantly from those of surface waters (large rivers). High deuterium concentrations are found in waters with high salinity and high content of organic matter; low deuterium contents are characteristic of waters high in radioactive elements but of low salinity. (auth)

40213 USE OF ^{15}N IN THE SOLID PHASE FOR DETERMINATION OF RADIOGENIC ARGON. Zadorozhnyi, I. K.; Volynets, V. F. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geochem. Int. (Engl. Transl.), 4: 545-50(1967).

The method of measurement of radiogenic argon involving the use of nitrogen-15 in the solid phase has several shortcomings, e.g., the formation of nitrogen oxides during decomposition of the potassium nitrate standard, and the unreliable control of atmospheric argon. Modifications are presented that would eliminate or minimize the deficiencies of the method. Though incapable of accurate measurement of small amounts of argon ($<10^{-15}$ cm^3) the method if so modified is rapid, simple and well suited for use in studies requiring analysis of a great number of samples of relatively high argon content. (auth)

40214 CONDITIONS OF ACCUMULATION OF URANIUM IN PEAT. Lopatkina, A. P. Geochem. Int. (Engl. Transl.), 4: 577-88(1967).

In waters of humid regions a considerable part of dissolved uranium is unstable and may be precipitated by peat. The concentrations of uranium in peat are determined by several factors: composition of peat, uranium content in water, and the total dissolved salt content of water. Under favorable geochemical conditions the concentration of uranium in peat depends, first of all, on its concentration in the inorganic residue left after evaporation of water. There is a linear correlation between these concentrations. Substantial enrichment of peat in uranium at the expense of rocks with low content of the element is improbable. (auth)

40215 $^{40}Ar/^{39}Ar$ METHOD FOR POTASSIUM-ARGON AGE DETERMINATION. Mitchell, J. G. (Cambridge Univ., Eng.). Geochim. Cosmochim. Acta, 32: 781-90(July 1968).

In the argon-40/argon-39 method of potassium–argon dating the potassium analysis is performed by mass-spectrometric measurement of the ^{39}Ar in neutron irradiated minerals. Sources of interference with the ideal mechanism are investigated and, with the exception of argon produced from isotopes of calcium, are shown to be negligible. It is demonstrated that for most materials used in potassium-argon dating this effect can be ignored. A demonstration of the method is described using samples of known potassium–argon ages. Some advantages over the conventional method are that the amount of material required is greatly reduced, no ^{38}Ar "spike" is required, and chemical inhomogeneity within a sample is of no consequence. Practical difficulties encountered are outlined. (auth)

40216 STUDIES ON THE SORPTION AND RELEASE OF RADIONUCLIDES BY RIVER SEDIMENTS. Kawabata, Toshiharu (National Inst. of Health, Tokyo). J. Radiat. Res., 8: 20-31(Mar. 1967).

Factors affecting the sorption of various radionuclides by a river sediment sample in the fresh or saline water were examined; in addition, release of radionuclides in the sediments when it was exposed to the sea water was studied. Water and sediment samples were collected at several places along the Sagami River, and radionuclides employed in these experiments were ^{90}Sr, ^{137}Cs, ^{54}Mn, ^{60}Co, ^{51}Cr and ^{59}Fe. Cation exchange capacity of the river sediments less than 120 mesh fraction was 1 meq/100 g determined by $CaCl_2$ method, and 2 meq/100 g by the tagged cesium method, and the capacity of acid treated river sediments by NaCl method was 1 meq/100 g, respectively. Uptakes of radionuclides by the sediments were much affected by various competing cations, and the rate of inhibition depends not only on the cationic species but also concentration of cations. The higher in the concentration of a competing cation, the more inhibitive to the uptake of radionuclides by river sediments. Release of radionuclides which had been sorbed by the river sediments in the filtered sea water was examined during 12 days storage. Both ^{60}Co and ^{137}Cs were released easily, and never were re-absorbed. The release of ^{90}Sr, however, increased for the first 2 days, then gradually decreased, which might be due to the re-absorption of the nuclide by sediments in the sea water. The rate of release of ^{54}Mn was rather low, in addition, the amount released in the sea water decreased gradually, which might be due to the precipitation in the form of MnO_2. (auth)

40217 ACCUMULATION OF RADIONUCLIDES IN COASTAL SEDIMENT OF JAPAN. I. FALLOUT RADIONUCLIDES IN SOME COASTAL SEDIMENTS IN 1964–1965. Nagaya, Yutaka; Saiki, Masamichi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 8: 37-43(Mar. 1967).

Nineteen samples of sediment collected from Tokyo Bay and coastal water along Fukushima Prefecture were analyzed radiochemically. The HCl-extraction efficiencies of radionuclides in sediment were examined. Recoveries of more than 80% were obtained for ^{144}Ce, ^{106}Ru, and ^{131}Cs in fine mud collected in Tokyo Bay. The "shaver type" sampling device was designed to collect a large amount of sediment of the surface layer of 2 cm thickness. ^{90}Sr, ^{137}Cs, and ^{144}Ce concentrations in fine mud were remarkably higher than those in sandy mud or sand. It was clearly observed that ratios of $^{144}Ce/^{90}Sr$ and $^{137}Cs/^{90}Sr$ in coastal sediments were substantially higher than those in sea water. ^{144}Ce and ^{137}Cs were found to be accumulated more effectively in the surface mud on the bottom of the sea, in comparison with ^{90}Sr. (auth)

40218 PROBLEM OF URANIUM GEOCHEMISTRY IN PHOSPHORITES. Nikolskaya, Yu. P.; Tarantsova, M. I. (Inst. of Physical Chemical Bases for the Processing of Mineral Raw Material, Novosibirsk, USSR). Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd., No. 12, 40-6(Dec. 1967). (In Russian).

Data resulting from study of chemical and phase composition of primary and secondary phosphorites are listed. In particular, deposits which are similar by genetic signs and geological age, but different by the character of the country are compared; carbonate and siliceous phosphorites predominate in the study. Geochemical regularities in the accumulation of U are found, as are similarities in the distribution of the two types of phosphorites. Diffraction patterns for most types are illustrated. For the first category fairly linear dependence of U concentration on P_2O_5 concentration is found; for the second, very low concentrations of U (ca. 1×10^{-3}%) were found to be almost independent of P_2O_5 concentration for most samples. (BBB)

40219 STUDY OF ^{131}I RETENTION BY IONIC EXCHANGE IN THE NATURAL SUSPENSIONS OF SURFACE LAKE WATERS. Furnica, Gh. (Institutul de Igiena, Bucharest). Igiena (Bucharest), 17: 135-40(Mar. 1968). (In Rumanian).

Data are reported on the retention of radioactive anions by the natural suspensions in surface lake waters. This process is attributed to colloidal adsorption to a degree of 15 to 25%, the remaining retention being due to anion exchange. The level at which ionic exchange takes place is of 2×10^{-12} iodine equivalents per 1 g mud. The iodine retained through ionic exchange by the mud can only be eluted with a NaOH solution. The retention is therefore strong. The determinations were carried out with an Amersham ^{131}I standard solution of 2.5×10^{-4} and measured with an efficiency of 40% with a NaI (Tl) well-shaped crystal counter. (BBB)

40220 DETERMINATION OF THE RADON DIFFUSION COEFFICIENT IN ROCKS BY THE INSTANTANEOUS SOURCE METHOD. Bulashevich, Yu. P.; Kartashov, N. P. Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 10, 71-6(1967). (In Russian).

The diffusion coefficient of rocks in place can be determined from the variation in radon concentration with time near an instantaneous artificial source. A test of the method gave consistent values at two different points—2.9 and 3.8×10^{-2} cm^2 sec, respectively; grain size was coarser in the second case. When the pores were filled with moisture the value dropped to 1.1×10^{-2} cm^2 sec. The helium diffusion coefficient can be calculated approximately from the radon diffusion coefficient. The method is simple to use, and particularly suitable for unconsolidated formations. (Geophys. Abstr.)

Meteorology

40221 (AD-668327) GAMMA-RAY FIELDS ABOVE ROUGH CONTAMINATED SURFACES. Bennett, Charles B.; Kehrer, Willard S.; Soule Richard R.; Corn, James P. (Naval Radiological Defense Lab., San Francisco, Calif.). May 6, 1968. 211p. (USNRDL-TR-68-20). CFSTI.

An experiment was performed to determine the effect of surface roughness on the gamma radiation exposure rate above fallout-contaminated surfaces. Gamma radiation measurements were made at heights of 1, 4, 8, and 16 meters and at horizontal distances of 0 to 128 meters from the center of a 10 ft dia circle of ^{198}Au contamination on various surfaces, from plate glass to $\frac{5}{8}$ in. gravel. Two supplemental tests were conducted with ^{177}Lu contamination on plate glass and $\frac{5}{8}$ in. gravel in an attempt to establish the energy dependence of the roughness effect. The measured values were numerically integrated to approximate the gamma exposure field above a uniformly contaminated infinite plane of the base material. For each surface material, the intensity of the gamma exposure field (in Roentgens per hour for a contamination density of 1 Ci/m^2, $r/hr/Ci/m^2$) was divided by the gamma intensity over a contaminated plate glass surface to obtain a surface roughness ratio for each of 4 heights. The 1-meter values are presented. (auth) (USGRDR)

40222 (AECL-2787) PROCEEDINGS OF THE USAEC METEOROLOGICAL INFORMATION MEETING HELD AT CHALK RIVER NUCLEAR LABORATORIES, SEPTEMBER 11–14, 1967. Mawson, C. A. (ed.) (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 624p. (CONF-670931). Dep. CFSTI. CAN $12.00.

Forty-eight papers were presented at the conference. Separate abstracts were prepared for 31 papers. Abstracts of 17 papers have appeared previously in NSA. For abstracts of these see abstract 21: 41033 and CONF-670931 in the Report Number Index. (R.C.K.)

For abstracts of individual papers see: 40223–40253.

40223 (AECL-2787, pp 1-20) VALIDITY OF CURRENTLY POPULAR PLUME RISE FORMULAS. Carson, James E.; Moses, H. (Argonne National Lab., Ill.).

The ground-level concentrations of pollutants downwind of a tall chimney decrease as the effective height of the stack increases. The effective height of the stack is the actual height plus the rise of the plume centerline due to momentum and buoyancy of the effluent. Over twenty plume rise formulas have been proposed, but none is widely accepted due in part to a lack of sufficient plume rise data for testing. 711 plume rise observations are used to test the ability of fifteen published formulas to predict plume rise. The plume rise data were obtained from stacks whose heat emission rate varied over four orders of magnitude. (auth)

40224 (AECL-2787, pp 59-76) RELATIVE DOSE FACTORS FROM LONG-PERIOD POINT SOURCE EMISSIONS OF ATMOSPHERIC POLLUTANTS. Start, George E.; Markee, Earl H. Jr. (Environmental Science Services Administration, Idaho Falls, Idaho).

A new technique for estimating air pollution exposures which result from long-period effluent releases is described. A continuous point source release is approximated by sequential instantaneous point source releases. The total effluent exposure effect of the release is determined from the summed total integrated concentrations from each instantaneous point release. These exposures are expressed as a relative dose factor, the sum of hourly values of total integrated concentration (units-hr/m^3). The new method is particularly useful for calculating relative dose factors in regions in which the winds undergo a marked diurnal cycling. The maximum mixing depth concept is adopted to limit vertical dispersion. As a computational simplification, the fields of atmospheric stability and wind within the boundary layer are assumed to have spatial homogeneity during each hourly computational interval. The technique is illustrated for a continuous, ground-level, point source release of effluent. However, elevated, intermittent, multiple point sources can equally well be incorporated in the model. The input data used for illustration are a sequence of the climatically most probable winds and stabilities within the atmospheric boundary layer over the NRTS. The technique has two other important potential applications. If the input data are the current observed meteorological parameters, the technique becomes a real-time method of evaluating the severity and extent of the relative doses resulting from accidental releases of hazardous atmospheric pollutants. When forecast meteorological parameters are considered, a predicted coverage, severity, and accumulation of atmospheric pollution is obtained. (auth)

40225 (AECL-2787, pp 77-86) THE USE OF DATA IN EVALUATING RADIATION HAZARDS ASSOCIATED WITH A REACTOR ACCIDENT. Moses, Harry; Bogner, Mary A.; Carson, James E. (Argonne National Lab., Ill.).

Wind speed, wind direction and stability measurements were used to evaluate the hazards associated with an assumed maximum credible reactor accident. Comparison of these results with those based on a constant wind direction, 2 meter per second wind speed and inversion conditions indicates a reduction factor of 10 for a 30-day iodine inhalation dose is reasonable when meteorological conditions are used. (auth)

40226 (AECL-2787, pp 87-104) AERODYNAMIC EFFECTS OF THE EBR-II CONTAINMENT VESSEL COMPLEX ON EFFLUENT CONCENTRATION. Dickson, C. R.; Start, G. E.; Markee, E. H. Jr. (Environmental Science Services Administration, Idaho Falls, Idaho).

Dispersion measurements of a tracer, uranine dye in solution, were made around a reactor complex to 600 meters from release point, in stable and unstable atmospheres. The tracer was released

from the northeast side of the EBR-II reactor containment vessel and sampled at the one meter level by 90 high-volume air samplers. Some 24 releases for 30-minute periods were analyzed. Techniques of dispersal, collection and analysis of the tracer are included. Meteorological measurements during tests included vertical and horizontal wind direction and velocity fluctuations at the six meter level at one upwind and several downwind locations and vertical temperatures at several levels on a 74 meter tower. It was found that the increase of the product of vertical and horizontal turbulence downwind of the structures over that in open terrain could exceed a factor of 15 at 100 meter downwind for 5-minute periods and averaged a factor of 5.0 for 30-minute periods. A counteracting measure is the factor of two decrease of the wind speed in the wake cavity of the structure. The average maximum arc concentrations were found to be proportional to the -0.6 power of distance downwind. No simple power law relationship was found for σ_y with distance downwind. Predictions of σ_y from σ_θ via the empirical relationship $\sigma_y = 0.035\sigma_\theta X^{0.87}$ were excellent. Several formulas were tested for calculating the diffusion in the wake of an obstacle. (auth)

40227 (AECL–2787, pp 132-6) SIMPLIFIED ATMOSPHERIC DIFFUSION CALCULATIONS WITH SLIDE-RULE GAGE POINTS. Gifford, Frank (Atmospheric Turbulence and Diffusion Lab., Oak Ridge, Tenn.); Waterfield, Robert (Atomic Energy Commission, Washington, D. C.).

Gage points are given with the help of which the most commonly required atmospheric diffusion calculations can be carried out rapidly using a simple slide-rule setting; e.g., maximum ground concentration, its distance, and the corresponding effective stack height as functions of the prevailing type of meteorological condition. (auth)

40228 (AECL–2787, pp 161-75) RADIOACTIVE AIR POLLUTION IN THE 9 D's. Holland, J. Z. (Atomic Energy Commission, Washington, D. C.).

Device sets the stage for the first act, written by nuclear engineers and physicists, in which Disposal begins the action while Decay gradually closes the curtain. Displacement provides the scene for the second act, written by meteorologists, in which turbulent Dispersion prevails until Deposition (both wet and dry) brings down the curtain. Dose opens the final act, in which the nature of Damage is revealed, and Disappearance ends the play. The attention in this critique is centered on Displacement and Dispersion, their changes of character with varying time and length scales, the deterministic nature of one and the statistical nature of the other, and their relevance to radioactive air pollution. (auth)

40229 (AECL–2787, pp 215-28) PLUME RISE AND DISPERSION NEAR THE SHORELINE OF A LARGE LAKE WHEN FLOW PATTERNS ARE DOMINATED BY THE LAKEBREEZE. Moroz, Wm. J.; Koczkur, E. (Univ. of Toronto, Ontario).

The rise and dispersion rates of plumes from a large thermal generating station located on the Lake Ontario shoreline in relatively flat terrain on the outskirts of a large city are examined under conditions where the local flow patterns are dominated by lakebreeze circulations. For the periods of analysis winds aloft were observed using pilot balloons released over the land near the source and temperature structure in the vertical was observed on both sides of the shoreline using an instrumented light aircraft. The plume was recorded for subsequent analysis using time lapse photographic techniques. Application of special films and filtering devices permitted observations to be extended beyond the point where the plume is no longer visible to the naked eye. Analysis of individual photographs is conducted using a photodensitometer to avoid error through the introduction of subjective interpretations. The position of the plume centerline in space and the vertical spread of the plume were determined under conditions of moderate wind shear in the vertical and a slightly stable lapse rate through the layer of rise and dispersion. Tall stacks are used at the particular station observed and plume rise is enhanced by relatively large momentum and buoyancy forces. It was found that well above the surface, despite a strongly buoyant emission, within the lakebreeze circulation system rise and rate of dispersion of a plume in the vertical were less than would normally be predicted on the basis of ground level observation of meteorological parameters. (auth)

40230 (AECL–2787, pp 229-40) ATMOSPHERIC TRANSPORT AND DIFFUSION AT COASTAL SITES. Van der Hoven, Isaac (Environmental Science Services Administration, Silver Spring, Md.).

On the average overland atmospheric diffusion rates are shown to be three times more rapid than those with overwater trajectories when the water is colder than the air temperatures over the land. The transport distance required to complete the transition from overwater to overland diffusion is shown to be a function of plume height, wind speed, and vertical temperature profile. Diffusion models are suggested to account for the diffusion rates within this transition zone. Coastline atmospheric trajectories are discussed in terms of local effects which result in the daily reversals between land and sea breezes and of large-scale pressure gradient effects which generally result in straight-line trajectories. (auth)

40231 (AECL–2787, pp 241-51) MESOSCALE DIFFUSION DERIVED FROM TETROON FLIGHTS. Angell, J. K.; Pack, D. H. (Environmental Science Services Administration, Silver Spring, Md.).

A summary is presented of continuous-point-source (CPS) and instantaneous-point-source (IPS) diffusion within the planetary boundary layer as obtained from tetroon flights at Los Angeles, Atlantic City, New York, and Idaho Falls. For downwind distances from 5 to 50 km, the IPS and CPS diffusion is proportional, respectively, to the 0.8 and 0.9 power of distance for the combined data. Over a day, CPS diffusion in the lateral direction is also proportional to release interval (in hours) to the 0.3 power. Based on the classical solution for Fickian diffusion, the coefficient of (horizontal) eddy diffusivity varies from 10^6 to 10^7 cm^2 s^{-1}. With the additional assumption that tetroon diffusion is a result of eddies within the inertial subrange, the dissipation averages 1.0 cm^2 s^{-3}. The variation with time of the square of the separation distances between simultaneously released tetroon pairs is in good accord with similar data, at larger and smaller scales, obtained by other workers. There is some evidence that this separation rate is largest from 5 to 10 minutes after release for pairs initially separated by the order of 100 meters. (auth)

40232 (AECL–2787, pp 252-62) DIFFUSION MEASUREMENTS AT MEDIUM RANGE FROM A CONTINUOUS POINT SOURCE. Peterson, Kendall R. (Environmental Science Services Administration, Silver Spring, Md.).

The structure of the Brookhaven plume on a day with neutral stability was delineated out to distances of about 150 miles downwind from the Brookhaven reactor. A vertical cross-section at 144 n miles from the source showed the plume to be well organized with good vertical mixing giving nearly uniform maximum concentrations to at least 2000 feet. The usefulness of a vertical sawtooth flight path was verified and is believed to be superior to a number of horizontal passes perpendicular to the plume. Peak concentrations, as observed, decrease by more than two orders of magnitude at a distance of 150 n miles and a travel time of 10 to 12 hours. Peak concentrations corrected for decay appear to decrease by about a factor of 7 to 10 over the same distance and time. The lateral standard deviation of the plume seems to fit an extension of the Pasquill-Gifford "D" curve with distance and is approximately equal in kilometers to 1.2t with time in hours. (auth)

40233 (AECL–2787, pp 263-70) MODELING AIR POLLUTION IN THE WASHINGTON, D. C. TO BOSTON MEGALOPOLIS. Slade, David H. (Environmental Science Services Administration, Silver Spring, Md.).

Simplified meteorological models and pollutant source configurations were used to demonstrate the types of pollutant patterns that might be encountered in the Washington, D. C.–Boston megalopolitan corridor. A semirealistic source distribution and source intensity of carbon dioxide were used in this demonstration. The results of the computations suggest that local increases in quantities of pollutants may at times require regional rather than local source consideration. (auth)

40234 (AECL–2787, pp 271-4) URBAN HEAT ISLAND AND SO_2 CONCENTRATIONS: AN AIR POLLUTION PROJECT AT UNIVERSITE DE MONTREAL. East, Conrad (Univ. of Montreal, Quebec).

A study of the problems that air pollution poses to large urban populations is described. A description of the project with emphasis on its goals, instrumentation, and operational techniques is presented. (R.C.K.)

40235 (AECL–2787, pp 292-306) LOW-LEVEL WIND AND TEMPERATURE INFORMATION FOR AIRCRAFT OPERATIONS AT AIRPORTS. Hilsenrod, Arthur (Federal Aviation Administration, Washington, D. C.).

The mesometeorological data used in turbulence and diffusion studies can be used to provide information that affect aircraft operations in the terminal area. It includes: wind shear, low level turbulence, conditions that propagate or dissipate aircraft wake turbulence, amount of agent to use in the dissipation of fog, and the propagation of noise. The FAA planned programs in wake turbulence and noise abatement are discussed. (auth)

40236 (AECL–2787, pp 307-19) DIFOUT: AN ATMOSPHERIC TRANSPORT AND DIFFUSION MODEL. Luna, R. E. (Sandia Corp., Albuquerque, N. Mex.).

A computer programmed model for prediction of the atmospheric transport and diffusion of aerosols was developed. The program is a melding of a U. S. code describing gravitational fallout of a log-normal size distribution of particles in a vertically-varying wind field and a U. K. code describing the dispersion of a particle cloud by atmospheric turbulence. At its inception the aerosol cloud is approximated by a series of cylindrical layers in the vertical direction characterized by a source strength, lateral diameter and thickness, and a distribution of aerosol mass with particle diameter. In turn, each layer is composed of several line source elements of equi-size particles to conform to the aerosol mass-diameter distribution for the layer. Each element descends at its gravitational fall rate and is transported by the mean vector wind while expanding by the action of turbulent diffusion. Deposition and/or airborne dosage is calculated on a specified circular grid of ranges and azimuths whose origin is at the cloud's initial position. Various input and output options are described which permit great flexibility in program use either in prediction of the dispersal from a given cloud or in the determination of the input necessary to produce a given result. An illustrative problem involving prediction of aerosol dosage at ground level from a possible SNAP system failure during a launch abort is provided. (auth)

40237 (AECL–2787, pp 320–33) A COMPUTER PROGRAMMED MODEL FOR CALCULATION OF FALL AND DISPERSION OF PARTICLES IN THE ATMOSPHERE. Hage, K. D. (Travelers Research Center, Inc., Hartford, Conn.); Church, H. W. (Sandia Corp., Albuquerque, N. Mex.).

An atmospheric model has been designed and developed to provide estimates of air concentrations or ground deposit densities of particles released in the atmosphere up to 90-km altitude. Particle density and diameter may range from 1 to 10 g/cm^3 and about 3 to 300μ, respectively, for given instantaneous point or line sources. The particle cloud is allowed to move horizontally in accordance with analytically simulated winds and to fall at terminal velocity plus vertical air velocity. Small-scale cloud growth rate is specified empirically at values based on past instantaneous tracer experiments while large-scale growth results from trajectory subdivision and divergence of new particle trajectories. Some specific computer runs were done to assess hazards resulting from possible rocket abort situations and atmospheric re-entry from improper orbits of isotopic or reactor power supplies. The results have been compared with other modes of estimation derived from simpler models of world-wide contaminant spread. While existing data are insufficient for full verification, it is felt that the present model is one of the most comprehensive and realistic available. (auth)

40238 (AECL–2787, pp 356–67) APPLICATIONS OF CLIMATOLOGICAL MEASUREMENTS. Moses, Harry; Carson, James E.; Ashby, W. C.; Bogner, Mary A.; Kulhanek, Frank C. (Argonne National Lab., Ill.).

More than 18 years of meteorological data have been collected by the Meteorological Group at the Argonne National Laboratory. These data have been useful in the day-to-day operations of the Laboratory and in the preparation of reactor hazard reports as well as in support of atmospheric research projects, such as radon, wind profile, plume rise and smoke diffusion studies. A climatological report, covering 15 years of data, has been prepared and will be published soon. A summary of a study of the meteorological conditions giving rise to dew point inversions (moisture content increasing with height near the ground) is given as an example of the type of studies that can be made with these data. (auth)

40239 (AECL–2787,pp 381–90) ON THE INDIRECT MEASUREMENT OF VERTICAL FLUXES NEAR THE GROUND BY VARIANCE REDUCTION ANALYSIS. Frenzen, Paul (Argonne National Lab., Ill.).

Equations are derived for diffusion by continuous movements by relating the mean-square dispersion achieved in one axial direction by an ensemble of particles at a time T after release from a point source, to the mean-square turbulent velocity of the particles and an integral of a Lagrangian autocorrelation function. The autocorrelation function is derived from a record of velocity fluctuations exhibited by a typical particle moving along a trajectory in response to the turbulent field of motion. (R.C.K.)

40240 (AECL-2787, pp 399-405) EFFECT OF HEAT FLUX ON THE ATMOSPHERIC TURBULENCE SPECTRA OVER LAND. Miyake, M. (Univ. of British Columbia, Vancouver); Badgley, F. (Univ. of Washington, Seattle).

The results of a study conducted at the AEC's Hanford Reservation, Richland, Washington made during one day using a three dimensional sonic anemometer–thermometer for fluctuation measurements, sensitive cup anemometer for wind profiles, and thermocouples for temperature profiles are presented. Other measurements using an ultra-fast response thermal probe and a hot-wire anemometer were made simultaneously but are not reported. The electronic and acoustic components of the sonic device are capable of responding to fluctuations up to hundreds of cycles per second but the length of the sound paths used, 30 cm, limits the meaningful response to about 10 cps, more or less, depending on the wind speed. The sonic instrument was mounted at a height of 4 m, mean winds and temperatures were measured at six heights from .75 to 24 m. The runs, were spaced one hour apart and each lasted for about one half hour. The early runs show unstable temperature stratification; run nine was approximately neutral; ten and eleven show stable stratification. The average wind speed varied throughout the day but the trend was towards higher speeds; run five had the lowest and run eleven the highest average speeds. Data for the profiles were recorded on punched paper tape; sonic data were recorded in FM format on magnetic tape. (auth)

40241 (AECL–2787, pp 406–14) A RESEARCH ABOUT THE BOUNDARY ATMOSPHERIC LAYER (AN APPLICATION OF LAIKHTNAM'S METHOD). Santomauro, L. (Brera Observatory, Milan, Italy).

A program of experimental research on the boundary atmospheric layer on the Po valley is described. The Po valley is characterized by stagnant meteorological conditions, and the land is flat and uniform for a considerable extension, particularly in the Milan area. Radiosondes were used for the experimental part. These radiosondes were particularly useful for the first atmospheric layers, and therefore, a rather large number of characteristic levels were available for study. Laikhtnam's method was applied to the first research phase; consequently the mean height of the boundary layer was determined both experimentally and by means of the equation: $[H^2(Y_a - \overline{Y})]/V_g^2 = [2.3(1 - \overline{\zeta})\ \overline{T}]/g = \text{const.}$ The mean turbulence coefficient was also calculated by means of the equation: $[\overline{k}(Y_a - \overline{Y})]/V_g^2 = \{[0.4(1 - \overline{\zeta})]/g\}\ w_r = \text{const.}$ It was found that the mean monthly height of the boundary layer varies from a minimum of 250 m to a maximum of 520 and that the mean turbulence coefficient is between 0.56 and 2.52 m^2/sec. (auth)

40242 (AECL–2787, pp 415–25) MICROMETEOROLOGY AT CRNL: SOME PROBLEMS AND SOLUTIONS. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

Research in meteorology at Chalk River has mostly been dictated by the needs of Health Physics. Two lines of research are described, one concerns the dispersion of stack gases, the other, the deposition of airborne radioactive contaminants onto the surface of the earth. The weather was disregarded but the effects of changing meteorological conditions were treated as a random variable. Diffusion is described in terms of frequency of occurrence of the effects on the contamination of the atmosphere to which it leads. The effects are represented by the ratio of the air concentration of a contaminant to its source emission rate. The research was conducted in connection with interest in containment and siting of reactors. (R.C.K.)

40243 (AECL–2787, pp 437–52) SOME CHARACTERISTICS OF RELATIVE PARTICLE DISPERSION IN THE ATMOSPHERE'S BOUNDARY LAYER. Kao, S.-K.; Wendell, Larry L. (Univ. of Utah, Salt Lake City).

The vertical, along- and cross-wind components of the relative positions and velocities of tetroon pairs were used to determine the auto- and cross-correlation functions, power- and cross-spectra, as well as the relative displacement tensor. It is found that, for all three components of the relative velocity, the power-spectra are practically coincident in the high frequency range from 1.4×10^{-3} to 5×10^{-3} cps. From the growth rate of the relative separation of particles, the along-, cross-wind and vertical components of the eddy diffusivity are estimated to be 5×10^7, 10^7, and 10^6 cm^2/sec, respectively. (auth)

40244 (AECL–2787, pp 453–61) THEORY OF THE EFFECTS OF STABILITY UPON THE WIND PROFILE UNDER CONDITIONS OF INHOMOGENEOUS TERRAIN ROUGHNESS. Blackadar, A. K.; Glass, P. E.; Panofsky, H. A. (Pennsylvania State Univ., University Park).

Whenever a wind (in the atmospheric boundary layer) which is in equilibrium with a surface of a certain roughness passes onto a surface of different roughness, finite intervals in time and space are required for the wind to come into equilibrium with the new surface. The depth of the layer within which the air is undergoing horizontal acceleration increases with increasing distance downwind from the change of roughness under conditions of neutral stratification. For non-neutral conditions of stratification, a perturbation-type theory was developed to describe the effect of non-adiabatic lapse rates on the depth of the accelerated layer. Under conditions of continuity of stress, wind speed, and wind

shear at $z = \eta$ (the height of the top of the accelerating layer) the equations of motion are integrated numerically through the accelerated layer. From this integral an expression for $\theta\eta/\theta\alpha$ (where α is the reciprocal of the Monin length) as a function of downwind distance from the change in roughness is obtained. The results of preliminary tests of the theory indicate a somewhat smaller effect of stability than that predicted in a theory suggested by Miyake as modified by Panofsky (1965); both theories predict an increase of η with increasing instability, other factors being equal. However, the effect of stability on η is so small and the scatter in presently available observations is so large that it is not yet possible to discriminate between the two theories. (auth)

40245 (AECL–2787, pp 463-75) MODIFICATION OF THE WIND PROFILE DUE TO CHANGES IN SURFACE ROUGHNESS. Smith, F. B. (Atmospheric Turbulence and Diffusion Lab., Oak Ridge, Tenn.).

Equations for the mean wind speed, the turbulent shearing stress and the eddy diffusivity are formulated in terms of height above ground, downwind distance and a surface drag coefficient, applicable to a layer in which the coriolis effects are deemed negligible. One empirical parameter is contained in these equations and it is found that the rate of climb of the so-called internal boundary layer, when air passes from one homogeneous surface terrain to another, depends selectively on this parameter. Experimental data appearing in the literature is at present insufficient to fix the parameter more than roughly. Several numerical experiments were carried out giving ostensibly sensible changes in the wind profile. Modifications to the basic equations, to allow for vertical velocities arising from height changes of the ground and from horizontal retardation of the air, are suggested. (auth)

40246 (AECL–2787, pp 476-84) THE EULERIAN–LAGRANGIAN TIME-SCALE RELATIONSHIP IN ONE-DIMENSIONAL TURBULENCE. Smith, F. B. (Atmospheric Turbulence and Diffusion Lab., Oak Ridge, Tenn.).

A relation between the two time-scales was found from considerations of particle acceleration which agrees well with experimentally determined values. Two basic assumptions are made: that the rate of change of particle velocity, relative to the mean wind, is due primarily to its transition through the complex turbulent field and not to the local time-distortions of this field; also that the Eulerian and Lagrangian acceleration-correlograms are mathematically similar. Extensions to two and three-dimensional turbulent fields are possible but cumbersome and result in little change in the time-scale relationship. (auth)

40247 (AECL–2787, pp 485-502) VARIATION OF THE LAGRANGIAN–EULERIAN TIME SCALE RELATIONSHIP WITH STABILITY. Gifford, F. A Jr. (Atmospheric Turbulence and Diffusion Lab., Oak Ridge, Tenn.).

A model of Eulerian fixed-point turbulent velocity fluctuations is combined with the inertial range form of the eddy energy spectrum to find an approximate relation between the Lagrangian and Eulerian fixed-point time-scales involving the eddy energy dissipation rate. This is evaluated by various schemes involving the similarity forms of the surface layer wind profile and the results compared with observed values based on surface layer wind and dispersion measurements. In agreement with data, the Lagrangian–Eulerian scale ratio, β, is found to vary with stability being equal to 1 to 3 during daytime, unstable conditions and 6 to 12 during nighttime, stable conditions. (auth)

40248 (AECL–2787, pp 514-26) HIGH-SPEED PHOTOGRAPHY STUDIES OF PARTICLE TRAJECTORIES AND DISTRIBUTIONS IN COLLISIONS WITH WATER DROPS. Berg, T. G. Owe; Gaukler, Thomas A.; Vaughan, Urte (T. G. Owe Berg, Inc., Santa Ana, Calif.).

An investigation of the washout of atmospheric particulates by rain, especially the effect of electrostatic charges upon the collisions between rain drops and particles is described. The objective was to investigate the high-speed photography technique to determine particle trajectories and distributions. Although the technique is limited with respect to drop size, drop velocity, and particle size, it permits, within these limits, the determination of trajectories of particles of known size and charge. (R.C.K.)

40249 (AECL–2787, pp 553-66) TRACERS FOR THE STUDY OF SCAVENGING BY RAIN. Dingle, A. Nelson (Univ. of Michigan, Ann Arbor).

The study of rain scavenging by means of tracers from crudely defined "natural" sources has led to the idea that the resolution of physical-problems of scavenging might be greatly improved by the use of artificially placed tracer. The selection of a suitable material to use in the study of strong convective systems, with measurement by neutron activation is discussed. The design, coordination and execution of a pilot experiment in a strong convective storm at Holdenville, Oklahoma, 30 May 1967 are recounted, and preliminary results of the neutron activation analysis are presented. Although statistics for the evaluation of natural background of the tracer material, indium, are not yet as numerous as desired, and the sample analyses are not all completed, the criterion for success of the pilot experiment, i.e., that the tracer be clearly identified in collected rain samples, is certainly met by the preliminary figures. (auth)

40250 (AECL–2787, pp 567-80) COSMIC RAY PRODUCED RADIONUCLIDES AS TRACERS OF ATMOSPHERIC PRECIPITATION PROCESSES. Wogman, N. A.; Thomas, C. W.; Cooper, J. A.; Engelmann, R. J.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Some of the long-lived cosmic ray-produced radioisotopes with half-lives greater than one week, have been used as tracers of atmospheric precipitation processes. The shorter-lived radioisotopes with half-lives of minutes to hours have a potential in defining precipitation scavenging mechanisms. Using highly sensitive multidimensional gamma spectrometers, the two short-lived cosmic ray-produced radioisotopes ^{38}Cl and ^{38}S were discovered in rainwater and techniques for the measurement of three other short-lived radioisotopes ^{34m}Cl, ^{39}Cl, and ^{24}Na in precipitation were developed. The technique provides a unique method for studying fallout rates and mechanisms and permits the investigation of processes which cannot be studied by any other method. (R.C.K.)

40251 (AECL–2787, pp 581-8) EFFECTS OF A FOREST ON PARTICULATE DISPERSION. Raynor, Gilbert S. (Brookhaven National Lab., Upton, N. Y.).

A study was conducted which had the following objectives: to determine the behavior of a plume as it approaches the forest edge as a function of release site and meteorological conditions; to determine the dispersion rate within the forest as compared to the rate over open terrain under similar conditions; and to identify the mechanisms important in the removal of particles from the air within the forest. The study area consisted of a fairly dense pine forest with trees about 11 m tall. Four principal effects were attributed to the forest: the plume broadened both horizontally and vertically by divergence of the wind at the forest edge; particles tended to penetrate at tree trunk height or to rise above the canopy; loss of particulates occurred mainly in two stages and by two mechanisms, impaction near the forest edge and deposition well within the forest; and total loss of particulates over the distance studied was considerably greater than over open terrain. (R.C.K.)

40252 (AECL–2787, pp 589-601) TURBULENT TRANSFER CHARACTERISTICS OF RADIOIODINE EFFLUENTS FROM AIR TO GRASS. Markee, Earl H. Jr. (Environmental Science Services Administration, Idaho Falls, Idaho).

A total of 20 controlled field releases of radioiodine were performed at the National Reactor Testing Station in Idaho as a portion of a program to study the transmission of gaseous radioiodine through the air-vegetation-cow-milk-human chain. Most of the releases were conducted over typical pasture grasses during different wind and stability conditions. Radioiodine adherence to grass and carbon plates was measured during most of the tests. Vertical air concentration profiles and turbulence parameters were measured to determine flux characteristics. Analysis of the data revealed the complex interdisciplinary nature of transfer of radioiodine from air to a natural surface. The data are in reasonable agreement with the deposition models of Sheppard and Chamberlain when corrections for the physical and biological receptiveness of the grass and grass density are made. The average ratios of momentum to mass flux were found to be 0.9 in stable conditions and 1.4 in unstable conditions. These ratios demonstrate the effect on mass flux in the lowest 4m by a surface that acts as a partial sink for gaseous effluents. The need for further research on the biological receptiveness of grass and turbulent transfer within a grass canopy was indicated. (auth)

40253 (AECL–2787, pp 602-14) PARAMETRIC STUDY OF GASEOUS PLUME DEPLETION BY GROUND SURFACE ABSORPTION. Markee, Earl H. Jr. (Environmental Science Services Administration, Idaho Falls, Idaho).

Total plume depletion by ground surface adsorption was calculated via the one dimensionsl parabolic diffusion equation. Solutions of this differential equation were obtained by digital computer for sets of eddy diffusivity (K) and wind velocity (u) profiles representative of stable, neutral and unstable conditions. Calculations were made for perfect sink and typical partial sink boundary conditions at ground level to a distance of 10^5 m from the source for various source heights. This method of estimating plume depletion was found to be extremely sensitive to K values in the lower levels and source height. The resultant vertical concentration profiles from a depleting plume show markedly non-gaussian distributions with the height of the maximum concentration increasing with

travel distance. This departure from the gaussian distribution is most pronounced in stable conditions. It appears that this parabolic diffusion equation provides realistic vertical concentration profiles and, consequently, reasonable plume depletion estimates. (auth)

40254 (ANL–7084) FIFTEEN-YEAR CLIMATOLOGICAL SUMMARY, JANUARY 1, 1950–DECEMBER 31, 1964. Moses, Harry; Bogner, Mary A. (Argonne National Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 671p. Dep. CFSTI.

Meteorological data pertinent to the problems of the atomic energy industry have been collected at the Argonne National Laboratory meteorology observation site since July 1, 1949. The data reported cover the period from January 1, 1950, through December 31, 1964. The data are presented in three parts. Separate abstracts were prepared for each part. (R.C.K.)

For abstracts of individual sections see: 40255–40257.

40255 (ANL–7084, pp 31-274) ANALYSIS BASED ON A SINGLE METEOROLOGICAL VARIABLE. (Argonne National Lab., Ill.).

An analysis of the meteorological variables measured at the Argonne Meteorology Site is presented in tabular form. Many statistical methods of presentation are used. Data are presented on the following topics: wind speed and direction; air temperature; atmospheric moisture; precipitation; stability; direct and diffuse solar radiation; net radiation; atmospheric pressure; and soil temperature. (R.C.K.)

40256 (ANL–7084, pp 275–497) RELATIONS BETWEEN TWO OR MORE METEOROLOGICAL VARIABLES. (Argonne National Lab., Ill.).

Meteorological data showing relations between two or more variables are presented in tabular form. Relationships between the following are given: wind speed, wind direction, and air temperature; wind speed, wind direction, net radiation flux, and solar radiation; precipitation; wind speed, wind direction, and relative humidity; air temperature, relative humidity, dewpoint temperature, and wet bulb temperature; air temperature, solar radiation, net radiation, and soil temperature; station pressure; and relative humidity and solar radiation. (R.C.K.)

40257 (ANL–7084, pp 499-671) COMPARISON OF METEOROLOGICAL PARAMETERS AT CHICAGO MIDWAY AIRPORT AND O'HARE INTERNATIONAL AIRPORT WITH THOSE AT ARGONNE METEOROLOGY SITE. (Argonne National Lab., Ill.).

Air temperature, relative humidity and dewpoint temperature, wind speed and direction, station pressure and precipitation amount measured at the Argonne Site are compared with corresponding measurements made a Chicago Midway Airport (the official Chicago station) and O'Hare International Airport for comparable observation times. The data are presented in tabular form. (R.C.K.)

40258 (BNL–50093) 1965 ENVIRONMENTAL MONITORING RADIATION LEVELS AT BROOKHAVEN NATIONAL LABORATORY. Hull, A. P. (Brookhaven National Lab., Upton, N. Y.). Sept. 1967. 27p. Dep. CFSTI.

Measurements of "natural background" radiation levels and of increments attributable to Laboratory operations obtained on site and in the vicinity of Brookhaven National Laboratory during 1965 are summarized. These increments include contributions from the gaseous and air particulate effluent of the Brookhaven Graphite Research Reactor stack, from multicurie field γ sources, and from the discharge of low-level liquid wastes from the Laboratory's sanitary waste treatment plant into the headwaters of the Peconic River. The natural background external radiation level declined to an average of 2.26 mR/wk during 1965. A small increment which became perceptible late in May was attributed to fallout from a foreign weapons test. The highest yearly on-site level attributable to Laboratory operations was 9.83 mR/wk (for 168 hr), well below the established radiation protection standards for individuals in controlled areas. The highest yearly average radiation level at the perimeter was 2.50 mR/wk, to which the ecology forest contributed 1.61 mR/wk and the balance was from ^{41}Ar. The total is 25% of the established yearly standard of 500 mR for individuals in uncontrolled areas. No airborne radioactivity attributable to Laboratory operations, other than ^{131}I, was detectable during routine environmental monitoring. The yearly average gross β concentration of samples counted after a 30-hr delay (to allow for the decay of almost all the natural radioactivity) was 0.25 pCi/m^3, with a 1-day maximum of 1.69 pCi/m^3 on May 26. Because of the possibility of using the low level of ^{131}I as a meteorological tracer to study stack effluent dispersion, efforts to sample and evaluate very low environmental concentrations of airborne ^{131}I were continued during 1965. The highest yearly average at the perimeter was determined to be 0.0035 pCi/m^3, which may be compared with the radiation protection standard concentration of 100 pCi/m^3 in the uncontrolled areas. Fallout ^{131}I from the foreign nuclear weapons test was also present in an average concentration of 0.0083 pCi/m^3 from May 21 to July 16. The activity in precipation declined to a monthly average of 8.2 nCi/m^2. The monthly average concentration was 123 pCi/liter. The largest daily samples, each 8.0 nCi/m^2, were collected on May 26 and 27. Liquid wastes discharged to the headwaters of the Peconic River averaged 38 pCi/liter, about 3.5% of a calculated radiation protection standard which assumes that the ^{90}Sr content is 20% and that the balance of the isotopes present are "unknown" β or γ emitters. The average of monthly downstream "grab" samples in the Peconic River ranged from 56 to 4 pCi/liter, while those from off-site control locations averaged 12 pCi/liter. The highest concentrations of individual isotopes in bottom sediments (11.2 pCi/g of ^{60}Co, 6.9 pCi/g of ^{137}Cs, and 1.3 pCi/g of ^{144}Ce) were found between the on-site outfall and a point about a mile downstream from the Laboratory perimeter. A similar distribution was found in underwater vegetation, the highest concentrations being 18.9 pCi/g of ^{60}Co and 28.4 pCi/g of ^{137}Cs. Concentrations in both sediment and vegetation were found to decline to near background levels beyond a distance of three miles downstream. The concentrations of ^{131}I in routine monthly milk samples obtained from several nearby farms were all <5 pCi/liter, except for a brief time late in May and early in June. The applicable radiation protection guide, assuming an intake of 1 liter/day, is 100 pCi/liter. The Environmental Monitoring Program established that during 1965 radiation levels attributable to Laboratory operations were maintained well below the established radiation protection standards of the AEC for external exposures, air particulate concentrations, and liquid effluent concentrations. Radiation levels attributable to fallout were also well below the established limits. (auth)

40259 (CONF-671214) ARBEITSGEMEINSCHAFT FUER SCHWEBSTOFFTECHNIK. SCHWEBSTOFFTECHNISCHE ARBEITSTAGUNG, 1967. (Study Group for Suspended Matter Technique. Suspended Matter Technique Meeting of 1967). (Mainz Univ. (West Germany). Institut fuer Angewandte Physik). Dec. 1967. 51p. (In German). Dep.

Nineteen papers presented at the conference on the technology of suspended matter are compiled. The topics discussed are: fine sieves with pores under 0.1 μm for sampling of suspended matter, electrical precipitation of radioactive aerosols, electron microscopic determination of flattening factors and size of cloud drops, comparison of several surface measurement methods, impactor system for study of air-colloidal substances, methods for detection of organic air-colloidal components in the atmosphere, ultrafine aerosols in reactor technology, ratio between dust and nuclei in various air masses, studies on the vertical distribution of carbon monoxide in roads with high commercial traffic, development of electron scattered gasoline injection in Volkswagen motor, chemical composition of atmospheric aerosols, measurement of the refraction index of atmospheric aerosol particles, production of ultrafine aerosols, mobility and diffusion coefficients of natural and artificial radioactive ions, mobility of small ions in air, detection of the scattered light by ultrafine aerosols, and analysis of β decay curves of radioactive aerosols after atom bomb tests. (J.S.R.)

40260 (NP–17543) THEORY OF PLUME RISE COMPARED WITH FIELD OBSERVATIONS. Publication No. 68-2. Hoult, David P.; Fay, James A.; Forney, Larry J. (Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.). Mar. 1968. 27p. Dep.

A theory for the rise of a plume in a horizontal wind is proposed in which it is assumed that, for some distance downwind of a high stack, the effects of atmospheric turbulence may be ignored in comparison with the effects of turbulence generated by the plume. The theory, an extension of the local similarity ideas used by Morton, Taylor and Turner, has two empirical parameters which measure the rate surrounding fluid is entrained into the plume. Laboratory measurements of buoyant plume motion in laminar unstratified cross flow are used to evaluate the empirical parameters. Using this determination of the parameters in the theory, the trajectories of atmospheric plumes may be predicted. To make such a prediction, the observed wind velocity and temperature as functions of altitude, and flow conditions at the stack orifice, are used in numerically integrating the equations. The resulting trajectories are compared with photographs of plumes from 500- and 600-ft high stacks made by Leavitt et. al., of TVA. Within 10 stack heights downwind of the stack, the root mean square discrepancy between the observed height of the trajectory above ground level and the theoretical value is 14%, which is about the uncertainty in the observed height. The maximum plume rise within the field of observation is compared with empirical effective

stack height formulas and with the present theory, and is found to be closer to the latter. (auth)

40261 ROLES OF MEAN MERIDIONAL CIRCULATION AND EDDY DIFFUSION IN THE TRANSPORT OF TRACE SUBSTANCES IN THE LOWER STRATOSPHERE. Gudiksen, Paul H.; Fairhall, A. W. (Univ. of Washington, Seattle). J. Geophys. Res., 73: 4461-73(July 15, 1968).

Recent estimates of mean meridional motions and eddy diffusion coefficients in the lower stratosphere and upper troposphere are used to study the roles of mean circulation and eddy mixing in determining the spread of tungsten 185 injected into the lower stratosphere in the Hardtack test series of 1958. The observed distribution of tungsten-185 is reproduced satisfactorily for a period of 18 months after the injection, provided that the diffusion coefficients estimated from heat flux data are reduced by a factor of about 8. The mean meridional circulation is found to play a minor role in the transport process, its chief contribution being to raise the center of maximum concentration by 2 to 3 km in the equatorial region, in agreement with the observations. The mean residence time for a tracer injected into the equatorial stratosphere between 18 and 20 km is found to be about 10 months, with most of the transport into the troposphere occurring at middle latitudes. (auth)

40262 NATURAL ATMOSPHERIC RADIOACTIVITY AND ITS DEPENDENCE ON SOME GEOPHYSICAL FACTORS. Pensko, J.; Wardaszko, T.; Wochna, M. (Central Lab. for Radiological Protection, Warsaw). Atompraxis, 14: 255-8(June 1968).

Observations were made on the dependence of natural gamma radiation background and ^{222}Rn concentration on various environmental factors. Differences between daily mean values of radon exhalation from soil greater than one order of magnitude were noticed, which cannot be explained on the basis of the instability of the diffusion factor. These differences are probably caused by variation of water or ice content in the soil influencing the mechanism of radon diffusion. From observation of the soil freezing effect on radon exhalation it may be supposed that the radon diffusion factor is considerably greater in ice than in water. In the period of soil-water freezing, the vertical distribution of radon concentration is quite different from that in normal conditions. (auth)

40263 MEASUREMENT OF THE SPECIFIC GRAVITY OF THE RADIOACTIVE FALLOUT PARTICLES PRODUCED BY THE THIRD CHINESE NUCLEAR TEST, MAY 1966. Fujita, Akira; Matsunami, Tadao; Mamuro, Tetsuo (Radiation Center, Osaka Prefecture). J. Radiat. Res., 8: 32-6(Mar. 1967).

The measurement of the specific gravity of the highly radioactive fallout particles from the third Chinese nuclear test explosion was made. The specific gravity ranged from 5.2 to 6.5 and there was a tendency that the specific gravity increased with increasing darkness of the particle color. In connection with the results obtained by the electron microprobe analyses made previously, it was assumed that the specific gravity increased with increasing ratio of iron to aluminium in the matrix materials. (auth)

40264 STUDY OF THE DISTRIBUTION OF CHARGES FOR "FREE" SHORT-LIVED RADON DECAY PRODUCTS. Serdyukova, A. S.; Savenko, E. I. Izv. Vyssh. Ucheb. Zaved., Geol. Razved., No. 8, 116-22(1967). (In Russian).

It is shown that the short lived radon decay products, when formed in air free of aerosol particles, carry practically no charge or are neutral. With increasing concentration of aerosol particles in the air, the fraction of charged free atoms of RaA (Po 218) decreases. When the air is heavily charged with aerosol particles the fraction of positively and negatively charged free atoms does not exceed 2.5 percent of the total number of free atoms. Inasmuch as the number of charged free atoms depends strongly on the extent to which the air is charged with aerosol particles, it is practically impossible to use precipitation in an electrical or magnetic field to determine the total amount of free atoms. (Geophys. Abstr.)

40265 DISTRIBUTION OF GLOBAL AND NET RADIATION OVER THE INDIAN OCEAN AND ITS ENVIRONMENTS. Mani, A.; Chacko, O.; Krishnamurthy, V.; Desikas, V. Arch. Meteorol., Geophys. Bioklimatol., Ser. B, 15: 82-98(1967).

Maps showing the distribution of global solar, net terrestrial and net radiation over the Indian Ocean area have been prepared from available observations, supplemented by calculations based on other meteorological measurements. Maps for 4 representative months for global solar and net radiation are presented. Global solar radiation shows minima over the equatorial monsoon regions and maxima over land in high pressure belts of the northern and southern hemisphere. Along the tropics of Cancer and Capricorn, the highest values of the order of 220 kcal/cm^2/yr occur over N. Africa and Arabia. While there is very little latitudinal variation over the ocean during the southern summer, the variations are marked during the northern summer. The geographical distribution is mainly zonal except in the low latitudes, where areas of higher or lower radiation are distributed according to regions of higher or lower amount of cloudiness. Net radiation over the ocean is always greater than that on the land. The distribution is mainly zonal, maxima occurring over the sea in the tropics, with the highest values in the North Arabian Sea and the ocean areas to the northwest of Australia. Minima occur over land in the arid regions of both hemispheres and in the monsoon areas where global solar radiation itself is low. There is very little variation over the ocean during the southern summer but variations are large during the northern summer. (Indian Sci. Abstr.)

40266 HIGHLY RADIOACTIVE FALLOUT PARTICLES FROM THE THIRD CHINESE NUCLEAR TEST EXPLOSION, OBSERVED IN CHIBA, JAPAN. Maruyama, Hideo; Abe, Siro; Watanabe, Hironobu. Nippon Genshiryoku Gakkaishi, 10: 374-7(1968). (In Japanese).

Highly radioactive fallout particles, originating from the third Chinese nuclear test explosion, were found on the roof of a building in Chiba, Japan, and their properties were measured. The density of the particles distributed on the ground was about 4 particles/m^2. The gross β-activity due to the fallout particles 2 days after the explosion was about 5,600 dps/m^2. The decay curves were measured on the particles collected, which revealed some differences between individual particles. Particle size distribution ranged from 3.5 μm to 23 μm and seemed to have small cut properties. The particle activity was proportional to the volume. Their specific activity was estimated at 0.44 dps/μm^3 10 days after the explosion. The γ-ray spectra of the particles isolated from the filter of an air liner and of the residue of the filter were measured. The results were compared with those from the first and second Chinese explosions. (auth)

40267 RELATION BETWEEN RADIOACTIVITY VARIATIONS AND ATMOSPHERIC MOTION. Kuzenkov, A. F. Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 4: 563-6(May 1968). (In Russian).

Repeated attempts have been made in the past to correlate the quantitative and qualitative changes of the radioactivity of the atmosphere with the movements of air masses, thus using the radioactive materials as a convenient tracer. This problem was further studied on the basis of new experimental data, trying to correlate variations of the radioactivity with various meteorological observations in the upper troposphere, specifically, with vertical movement of the air. The artificial radioactivity of the air was determined on samples collected by planes in the European part of the Soviet Union during the winter months of 1964-5, at heights of 9 and 11 km. Deviations of the β activity from the mean monthly value were compared with vertical air movements before and after the measurements. It was found that in 70 to 80% of the cases, the increase of the concentration of radioactive materials is related to a wide, slow, downward moving cold front in westerly direction at 100 and 300 millibar level during the day of the measurement; the increase of the radioactivity of the air corresponded in 80% of the cases to a slow-moving barometric depression at the same levels during the 3 to 4 days prior to or on the day of the measurements. (TTT)

40268 ACCOUNT OF RESULTS OF A RADIOACTIVITY MONITORING SCHEME IN MONMOUTHSHIRE. James, G. V. J. Ass. Public Anal., 40: No. 3, 52-8(1966).

The sampling scheme and methods used for measuring radioactive pollution of the atmosphere, water and sewage are outlined, and results are summarized and discussed. (Anal. Abstr.)

40269 RELATIONSHIPS OF PHYSIOGRAPHY AND MICROCLIMATE TO FALLOUT DEPOSITION. Whicker, F. Ward; Loveless, Charles M. (Colorado State Univ., Fort Collins). Ecology, 49: 363-6(Early Spring 1968).

Measurements of fallout concentrations in various media were made on four physiographically contrasting sites within a 2-hectare mountainous area in Colorado. Air concentrations of radioactivity were lowest on the north and west slopes as a possible result of air filtration by foliage and lower dust concentrations. Fallout deposition on vertical gummed surfaces was highest at the south and west sites in apparent relation to higher mean wind velocities. Fallout deposition via rainfall was related to amounts of precipitation, but the monthly variations in both measurements were much higher than site variations. Fallout accumulation in soil was lowest on the timbered north slope. Significant differences in plant concentrations of radioactivity were found among species and sampling dates, but no differences were apparent among the four sites. (auth)

40270 DEPOSITION OF RADIOACTIVE FALLOUT IN NIIGATA CITY, JAPAN. REPORT 3. RADIOACTIVE CONTAMINATION OF RAIN, SNOW, AND ATMOSPHERIC DUST OBSERVED IN 1965 TO 1966 YEAR. Kosaka, Takao; Sugai, Ryuichi (Niigata Univ., Japan). Niigata Igakkai Zasshi, 21: 670-3(Dec. 1967). (In Japanese).

Concerning the radioactive fallout in rain, snow, and atmospheric dust in Niigata City in 1965 and 1966, the following observations were made: the radioactivity in rain, snow and atmospheric dust decreased somewhat in 1965, compared with the preceding year. But in 1966 they increased two-fold from 1965, due to the three nuclear tests in mainland China; the seasonal changes in fallout in the two years were different from those in the previous years, the amounts were high in spring and winter and low in summer and autumn; the deposition of highly radioactive particles, due to the nuclear tests in May and December 1966, was considerable, and the amount in December 1966 marked the highest since 1954; and in general, the state of nuclear tests was well reflected in the state of fallout, especially of atmospheric dust. (NSA of Japan)

40271 DEPOSITION OF RADIOACTIVE FALLOUT IN NIIGATA CITY, JAPAN. REPORT 2. RADIOACTIVE CONTAMINATION OF RAIN, SNOW, AND ATMOSPHERIC DUST OBSERVED IN 1963 TO 1964 YEAR. Kosaka, Takao; Sugai, Ryuichi (Niigata Univ., Japan). Niigata Igakkai Zasshi, 81: 664-7(Dec. 1967). (In Japanese).

Concerning the radioactive fallout in rain, snow and atmospheric dust in Niigata City in 1963 and 1964, the following observations were made: the radioactivity in rain, snow and atmospheric dust, in 1963, was nearly the same as in the preceding year, and in 1964 decreased to less than one-seventh of that in the same year; the amount of fallout in 1964 was the second lowest, with the lowest in 1960; the radioactivity, as in the previous years, tended to be low in spring and summer and high in autumn and winter, especially in atmospheric dust; radioactive fallout temporarily increased in October 1964, due to the first Chinese nuclear test, but in and after November it returned to normal; the amount of fallout in January 1963 was very high, similar to the peak values in September and October in 1958; and in general, the state of nuclear tests was well reflected in the state of radioactive fallout. (NSA of Japan)

Mineralogy and Exploration

Refer also to abstract 40516.

40272 (AEC-tr-6942) USE OF SMALL COMPUTERS FOR EVALUATION OF GAMMA BORE LOGS. Hartmann, Lothar; Henkel, Wolfgang. Translated from Z. Angew. Geol., 13: 212-17(1967). 15p. Dep. CFSTI.

A new method is described for evaluating gamma well logs recorded point-by-point, using the small automatic computer "Cellatron" SER 2b. This method is based on a theory developed by R. Roesler. Contrary to other methods it is operated on a purely numerical basis which makes it possible to use small computers. The principle and advantages of the method are discussed. (auth)

40273 STATE OF THE TECHNOLOGY OF PROCESSING LOW GRADE URANIUM ORES. North, A. A.; Fletcher, A. W. (Warren Spring Lab., Stevenage, Eng.). J. Brit. Nucl. Energy Soc., 7: 249-56(July 1968).

The processing of low grade ores of uranium is reviewed. Consideration is given to existing methods for the treatment of ores containing important primary or secondary uranium minerals in association, sometimes, with particular gangue or valuable minerals which have a major influence on chemical and physical aspects of processing. The various methods used for the recovery of uranium from leach solutions or pulps are discussed. In addition, recent developments and research in progress on many aspects of processing are described. (auth)

40274 URANIUM IN NIGER. Com. Naz. Energ. Nucl., Notiz., 14: No. 6, 60-1(June 1968). (In Italian).

The orebodies recently discovered in Niger form the largest uranium district in the world. Since 1954 France's CEA has been carrying out exploration and development programs in Niger. This article describes the Arlit deposits and some plans for construction of uranium plants. (auth)

40275 SOLUTION MINING OF URANIUM. Anderson, J. S.; Ritchie, M. I. Mining Congr. J., 54: 20-3; 26(Jan. 1968).

To apply solution mining of uranium, the ore should occur in a horizontal bed underlain by an impermeable stratum, below the static water table, and in sufficient content to justify the expensive leaching process. The production of uranium ore at Shirley Basin, Wyo. has continued by solution mining. Considerations, problems, and equipment development are discussed. (J.C.W.)

40276 PRESENT STATUS OF URANIUM EXPLORATION. Groth, Frederick A. (Kerr-McGee Corp., Denver, Colo.). Mining Congr. J., 53: 84-8(Nov. 1967).

A projection of uranium ore deposits is presented. The tonnage of uranium ore produced before 1966 is tabulated and percentages supplied by states in the USA are given. The estimates of reserves by states and the distribution of deposits by lithology are given. (J.C.W.)

40277 ON PARTITION AND AGE DETERMINATION OF URANIUM IN THE LIGNITES OF TRIMMELKAM, UPPER AUSTRIA. Vohryzka, K. (Montanistische Hochschule, Leoben, Austria). Berg Huettenmaenn. Monatsh., 11: 368-73(Aug. 1966). (In German).

A further study of the richest U-containing lignite in Austria is reported; 50% of the emitting centers are reported to have a circular cross-section with a diameter of 0.1 mm; the others have an elliptical cross section of major and minor axes 0.2 and 0.1 mm, respectively. A fraction of the irradiating material is disperse and possibly adsorbed on the lignite, without forming minerals. Partition of the centers varies from 5 to 20 per cm^3 in the cross sections examined. Orientation of the centers with stratification is noted. Xylitic portions are free from irradiating materials. Fluorescence and radiometric measurements are compared. For lignite, the content is ca. 250 g U/ton ore; lignite from Unterflöz is ca. 500 g U/ton ore. Geological formations are discussed. (BBB)

40278 GEOCHEMICAL SURVEY OF WESTERN SICILY. Dall'Aglio, M. (CNEN-CSN, Rome). Riv. Mineraria Sicil., No. 100-102, 19p.(1966). (In Italian). (RT/GEO(68)5).

A regional geochemical survey carried out in the western part of Sicily is described. This survey was carried out in order to acquire an inventory of the mining possibilities of this area with particular concern for uranium and phosphate ores. More than 300 samples of surface waters and of alluvial collected, over an area of 6,000 km^2 were analyzed. The information related with the study may be summarized as follows: even if sharp anomalies have not been discovered, some haloes have been identified in Magazzolo and in Verdura rivers. In these areas it is advisible to carry out more detailed geological and geochemical studies in order to identify the origin of the anomalies; the anomalous alluvial samples for the phosphate content show a significant concentration in the area of the hydrogeochemical anomalies for uranium and in the northern area of Partinico; and the analysis of the major inorganic constituents of the waters, reported as a byproduct of the survey carried out principally for mining purposes, has a significant importance for the utilization of natural waters. The knowledge of the water qualities is useful for direct utilization of surface water and in checking the most promising areas of ground waters to be used for civil purposes. (auth)

Seismology

40279 HIGH-RESOLUTION SEISMIC UPHOLE SURVEYS AT THE LAWRENCE RADIATION LABORATORY. Carlson, R. C. (Lawrence Radiation Lab., Mercury, Nev.); Stearns, R. T.; Berens, H. B.; Hearst, J. R. Geophysics, 33: 78-87(Feb. 1968).

Use of the uphole survey method to achieve high resolution velocity measurements for underground nuclear explosion seismic studies is reported. Methods were developed to measure the source and arrival times of an explosion-induced acoustic wave to within 0.1 msec. These methods were used to measure acoustic velocity over distances of 10 to 150 m with high accuracy. The methods are usable in dry holes, and were used in rhyolite, tuff, dolomite, alluvium, and shale to measure velocities between 700 and 5000 m/sec. Statistical errors on the order of ±2 to 5% were achieved in most cases. It is concluded that the accuracy of such measurements is limited only by the frequency transmission of the medium, not by the instrumentation. The instrumentation used is described. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstract 40478.

40280 (AD-667933) A DETECTOR ENERGY INTEGRATION PROGRAM DESIGNED TO OPERATE ON THE NGM CODE OUTPUT. Vogt, David; Grayer, Jack (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Mar. 1968. 114p. (NDL-TM-40). CFSTI.

A Neutron-Gamma Monte Carlo (NGM) transport code that will produce a differential data map of the radiation environment created by a nuclear detonation is described. The output provides fluxes at a series of detectors surrounding the detonation, normalized to one neutron leaving the source in the given source-energy solid angle group. By appropriately weighing the output and integrating it with respect to the variables, the radiation field of given weapons can be theoretically predicted. A set of codes has been written to perform this flux integration over any of the desired variables (source energies and angles; detector energies, angles, and times), with weighting facility to handle specific situations. A digital computer program written for the GE-225 computer is described. The program integrates the NGM radiation transport code differential flux output over the detector energy spectrum weighted by a specified function. (auth) (USGRDR)

40281 (PNE-602F) GEOLOGIC AND ENGINEERING PROPERTIES INVESTIGATIONS. Project DUGOUT. Lutton, R. J. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Dec. 1967. 188p. Dep. CFSTI.

The Dugout event was a row cratering experiment in which five 20-ton nitromethane charges spaced 45 feet apart at depths of 59 feet in dry basalt were detonated simultaneously. The explosion produced an apparent crater about 135 feet wide, 285 feet long, and 35 feet deep. Preshot and postshot NX core and calyx hole drilling, trenching, laboratory analysis of core samples, and analysis of photographs have revealed preshot structure, the extent and characteristics of the ejecta and fallback, the zone of blast fracturing, the zone of bulking, and a sheared zone. As revealed by preshot drilling, the upper basalt layer consists of about 40 feet of vesicular basalt overlying, with a gradational contact, about 50 feet of dense basalt. The vesicular basalt has been subdivided into four types on the basis of vesicle content and fabric. From 2 to 14 feet of silt overlies the bedrock. Unconfined compressive strength for 6 samples ranges from about 7,000 to 17,000 psi. Samples of dense basalt tested triaxially show a greater increase of strength with confining pressure than does a sample of vesicular basalt. Dynamic laboratory tests gave a compression wave velocity of 16,000 ft/sec for dense basalt and about 13,000 ft/sec for slightly vesicular basalt, and they indicated that Poisson's ratio averages about 0.25. Field seismic and vibratory studies indicate compression and shear wave velocities of about 1,000 and 700 ft/sec, respectively, in the surface soil and 4,000 and 1,300 ft/sec, respectively, in highly vesicular basalt. Flow layers complicating the otherwise simple stratigraphy form a system of nested cylinders with a mutual axis that parallels the direction of flow of the lava while it was still partly molten. Natural and blast-induced fractures have a preferred orientation parallel to flow layers. A second preferred orientation of joints is perpendicular to flow layers, but one major set of this group oriented normal to the cylinder axis is believed to be the dominant structural element modifying the crater process. A more or less continuous blanket of ejecta extends as far as 500 feet (in one direction) laterally from the preshot position of the line of charges. This granular material has a bulking factor of about 1.39. In the subsurface, the zone of in situ bulking and the zone of blast fracturing extend laterally as far as 250 feet, but in detail there appears to be a concentration of fracturing at a depth of about 60 feet. A zone of shear deformation extends at least as far laterally from the row charge as 100 feet. In each of these three subsurface zones the intensity of deformation decreases outward. The zone of blast fracturing along the projection of the row charge extends only about 160 feet from the end charge position, and the zone of shear deformation extends about 140 feet. A fourth zone characterized by relative displacement of points toward the crater with respect to points below is evident along the lip at the west end of the crater. (auth)

40282 (PNE-1116) STRUCTURES INSTRUMENTATION. Project PRE-GONDOLA II. Ballard, Robert F. Jr. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). May 1968. 55p. Dep. CFSTI.

Five seismic recording stations were operated during the PRE-GONDOLA II 140-ton row-charge experiment at Fort Peck, Montana. Amplitudes of 10^{-2} to 10^{-1} cm/sec peak velocity were recorded at seismic stations located near the center of the dam, in the reservoir, Gate Control Structure No. 3, Powerhouse No. 2, and on the spillway. Amplitudes predicted on the basis of earlier 0.5- and 20-ton experiments were moderately low. The yield scaling exponent was increased from 0.67 to 0.75 to increase the accuracy of the structure response prediction equation. Magnetic tapes were subjected to RMS time history and power spectral density analysis from 0.5 to 20 Hz over a period of 160 sec. (auth)

40283 (UCRL-50420) TERRAIN CORRECTIONS FOR BOREHOLE GRAVIMETRY. Hearst, J. R. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 30, 1968. 12p. Dep. CFSTI.

A computer program for the application of terrain corrections to borehole gravimetry measurements is described. The method involves the acquisition of the average elevations in each compartment from topographic maps. It would be possible to "read" the maps with a computer flying-spot scanner, but the effort involved in preparing suitable maps and programming would be much greater than that involved in hand-reading. A listing of the FORTRAN program MORIA is given. The code was checked against Hammer's surface corrections and found to be correct. (R.C.K.)

40284 (UCRL-70630) LEACHING OF RADIONUCLIDES AT SEDAN CRATER. Koranda, John J.; Martin, John R.; Wikkerink, Robert W. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 25, 1968. Contract W-7405-eng-48. 44p. (CONF-680308-12). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

The distribution of tritium and long-lived gamma radioactivity in crater ejecta from the Sedan detonation was studied. Tritium concentrations were determined in soil water extracted from crater ejecta samples collected from the surface to six feet, and at distances of 3000 feet from the crater. The distribution of tritium was very obviously modified by postshot environmental effects, especially rainfall leaching. Tritium maximum concentrations were found below the strata in which they were deposited. Gamma radionuclides exhibited limited movement in the crater ejecta strata or in preshot soil covered by Sedan ejecta. A subtle leaching of ^{137}Cs was demonstrated by considering the $^{137}Cs/^{54}Mn$ ratios in the ejecta strata. (auth)

40285 CRATERS FROM SURFACE EXPLOSIONS AND SCALING LAWS. Vortman, L. J. (Sandia Corp., Albuquerque, N. Mex.). J. Geophys. Res., 73: 4621-36(July 15, 1968).

Scaling laws for craters from surface explosions are derived from the nuclear explosions and applicable chemical explosions to date. The data are insufficient for defining scaling more accurately than by a first-order power law. Nuclear and chemical explosions are consistent in indicating that of the crater radii scale as a power of energy larger than $\frac{1}{3}$. A possible explanation of the larger scaling is hypothesized. (auth)

40286 AEC'S PLOWSHARE PROGRAM: UNDERGROUND NUCLEAR BLASTS FOR WASTE DISPOSAL. Com. Naz. Energ. Nucl., Notiz., 14: No. 6, 70-1(June 1968). (In Italian).

Consideration is being given to the use of underground nuclear explosions to create cavities for final disposal of wastes from nuclear industries. (auth)

40287 MINE-WORKING USING UNDERGROUND ATOMIC EXPLOSIONS. Delort, F. Rev. Ind. Minerale, 49: 729-39(Oct. 1967). (In French).

The effects of underground atomic explosions and the possible applications for bulk blasting, lixiviation, and open-cast mine working techniques are described. For blasting, nuclear blasts would break rock (100 million tons for a 70 kt shot) in areas too difficult to be worked conventionally. In situ lixiviation is applicable in rubble-shute working and useful for copper and uranium. Problems of safety, radioactivity, and seismic shock are minor in bulk blasting and leaching methods. These problems are greater with open-cast mines excavated by nuclear craters. (J.C.W.)

Facilities and Equipment

Refer also to abstracts 40317, 40334, 41015, 41136, 41503, 41516, 41517, 41521, 41530, 42199, and 42579.

40288 (AI-AEC-12681) HIGH HEAT FLUX HEATER DEVELOPMENT STATUS REPORT. McKisson, R. L.; Babbe, E. L. (Atomics International, Canoga Park, Calif.). June 15, 1968. Contract AT(04-3)-701. 38p. Dep. CFSTI.

The development of a high heat flux heater for use in corrosion rate and stress-rupture tests of fuel cladding materials in a sodium environment is described. The heating unit consists of a graphite rod, $\frac{1}{8}$-in. in diameter and 2 in. long, in which up to 3.77 kw of electrical energy is dissipated. A boron nitride sleeve is used as the primary electrical insulator for the graphite, and the heater sheath is made of Type 304 stainless steel. Heat fluxes of 1.3×10^6 Btu/hr-ft^2 have been attained at the heater sheath for periods exceeding 1000 hours. Heater operation and failure modes are discussed, and methods of increasing heater life are described. (auth)

40289 (BNWL-809) EVALUATION OF UNARCOBOARD-36 STRUCTURAL INSULATING PANELS. Davis, N. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 40p. Dep. CFSTI.

Unarcoboard-36 insulating precast structural material was evaluated. The physical integrity of the material by use of compressive strength tests made after the material had been subjected to various environmental conditions was determined. These conditions simulated the proposed application of this material in a radioactive waste storage tank installation. (J.C.W.)

40290 (CEA-R-3345) RADIO-VULCANISATION DU CAOUTCHOUC NATUREL EN PHASE LATEX ETUDE D'UNE PRODUCTION EXPERIMENTALE DE 1 TONNE PAR HEURE. (Radio-Vulcanization of Natural Rubber in the Latex Phase. Study of an Experimental 1 Ton per Hour Production). Leveque, Pierre; Puig, Jean-Rene; Roudeix, Henri (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1968. 76p. (In French). Dep.

After a brief review of the research carried out on the radio-vulcanization of latex and elastomers, a description is given of 4 types of cell which have been used successively with a view to industrial irradiation. They have made it possible to acquire the information necessary for resolving the main problem arising during irradiation – the formation of coagulum. The first two cell are designed for irradiation by a horizontal beam ("Dynamitron"), the two others use a vertical beam ("Circé"). The study of the properties of the rubber shows it to compare favorably with "Revultex". An appendix gives some characteristics of natural latex and information about its processing. (auth)

40291 (GEAP-5636) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. Eleventh Quarterly Report, Phase II, January-March 1968. Moen, R. H.; Gifford, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1968. Contract AT(04-3)-189. 17p. (EURAEC-2046). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Progress is reported on the development of a radial vane steam separator: The model separator performed satisfactorily in wall cylinders which give a 1-inch or a $\frac{1}{2}$-inch clearance gap between the upper vortex and the separator vanes. Thus, there was an increase in the probability that the large diameter separator, as requested for the KRB reactor, will perform satisfactorily with a small clearance gap. However, with the addition of core spray and feedwater sparger pipes to the system, carryover becomes excessive with the separator operating at KRB flows and water level. This problem appears to be solvable by extending the wall cylinder to a smaller diameter in the core spray pipe region and extending the cylinder to some point below the feedwater sparger pipe. Another test will be required to demonstrate the solution. (auth)

40292 (ORNL-4251) MOLTEN-SALT FLUORIDE VOLATILITY PILOT PLANT: EQUIPMENT PERFORMANCE DURING PROCESSING OF ALUMINUM-CLAD FUEL ELEMENTS. Nicol, R. G.; McDuffee, W. T. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 36p. Dep. CFSTI.

Irradiated aluminum-clad fuel elements were successfully processed in the Molten Salt Volatility Pilot Plant. The rate of equipment failure and the levels of necessary equipment maintenance were comparable to those observed previously with zirconium- or Zircaloy-clad fuels. None of the runs had to be terminated because of equipment failure. (auth)

40293 (RISO-M-760) TEST OF BURN-OUT METER. Skanborg, P. Z. (Danish Atomic Energy Commission, Risoe. Research Establishment). June 1968. 7p. (R-19-68). Dep.

The burnout meter gives information about the cooling properties at the place where the detector is placed in a coolant flow. It consists of an electrically heated Pt wire. The meter has been preliminarily tested out-of-pile and in-pile and may possibly be used to protect the fuel elements in power reactors. (auth)

40294 (TID-4100(Suppl.45)) ENGINEERING MATERIALS LIST. Supplement 45. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). July 1968. 77p. DTIE Free.

Thirty-one packages of engineering materials on nuclear instrumentation; fluorine cells and equipment; spark gaps; x-ray generators; oscillators, amplifiers and preamplifiers; waste water monitoring systems; glove boxes; calorimeters; contamination alarm systems; polarographic equipment; zonal centrifuges; accelerator equipment; ultrasonic scanners; spectrometers; gas coolers; surge tank recombiners; and weatherproof instrument cabinets are announced for inclusion in TID-4100. (R.C.K.)

40295 TUNGSTEN-RHENIUM [ALLOY] THERMOCOUPLE APPLICABLE UP TO 2600°C. Neugebauer, J.; Kortvelyessy, L. Meres Automat., No. 12, 365-71(1966). (In Hungarian).

A new type of thermocouple comprising W-20% Re vs W-5% Re is claimed to give a thermoelectric output of E = 24.18 mV at 1600°C and good stability at ≈2600°C when used in reducing atmosphere. The wires were prepared by powder metallurgy and were 0.5, 0.18, and 1 mm dia. The calibration curve follows a straight line up to 2000° and above that it decreases by 14 to 7 μV/°C. (J.R.D.)

40296 METHOD FOR PARTIAL X IRRADIATION, USED FOR LOCALIZED REMOVAL OF A PART OF THE INSECT BRAIN. Buchholtz, Christiane (Univ., Marburg, Ger.). Strahlentherapie, 134: 138-50(Sept. 1967). (In German).

A method for partial x irradiation using micro-diaphragms up to 25 μm was described. The x-ray unit (Müller MG 150) with the tube MÖ 100/Be and a binocular microscope (manufactured by Leitz) was used. A high dose rate was obtained by the use of a lead glass capillary (total reflection), a focus area with a thick layer, and reduction of the target-object distance. Non-localizing factors that occurred during partial irradiations were discussed. (auth)

40297 HAWAII DEVELOPMENT IRRADIATOR FACILITY (Engineering Materials). (Nuclear Materials and Equipment Corp., Apollo, Pa.). (CAPE-1741).

The Hawaii irradiator facility consisting of a concrete shielded cell with a labyrinth-type entry, water filled storage pool, source elevator for transporting the source into the cell to a horizontal slab position, conveyor system for product transport into and out of the cell, and source tools is described. Source BNL standard strips held in holders make up the source slab. The holders are contained in a carriage which is part of the elevator system. The carriage is moved by two endless chains which are sprocket driven from above the cell floor. The carriage rides on wheels contained in tracks providing minimum probability of jamming. The carriage turns to a horizontal position above the water surface and rides to an indexed position between the product process conveyors. The conveyor system handles two modes of operation: two-pass source overlap and four-pass target overlap. The system has three sections: the loading station which provides automatic loading and unloading of package carriers; transfer conveyor which transports the carriers between the loading area and the cell; and the process conveyor which transports the carriers over and under the source. Overall throughput is based on a mean papaya processing rate of 4,000 lbs/hr with a maximum of 8000 and a minimum of 600 lbs/hr. (For details see TID-4100 Suppl. 46). (F.S.)

40298 NUCLEAR POWER PIPING (USAS B31.7). Draft USA Standard Code for Pressure Piping. New York, American Society of Mechanical Engineers, 1968. 382p. $5.00. (NP-17499).

A Nuclear Power Piping Code is presented which provides requirements for the design, materials, fabrication, assembly, erection, installation, and examination of three classes of piping systems for nuclear power plant service. The three classes which denote three levels of quality are described as follows: Class I Piping – those piping systems whose loss or failure could cause or increase the severity of a nuclear incident; Class II Piping – those piping systems whose loss or failure could cause a hazard to plant personnel but would represent no hazard to the public; Class III Piping – those piping systems that normally would be Class II piping except that the operating pressure shall not exceed 150 psig and temperature shall be below 212°F. The Code is divided into three major subsections, one for each of the three classes of piping. Each subsection is divided into chapters covering the following topics: scope and definitions; design; materials; dimensional requirements; fabrication, assembly, and erection; and examination and test. (R.C.K.)

40299 STEAM GENERATOR (Engineering Materials). (Babcock and Wilcox Co., Lynchburg, Va.). (CAPE-1751). 12 drawings.

A once through steam generator is described which produces steam at the lowest cost with consideration for capitalization and maintenance cost within limitations imposed by the specifications. The generator achieves a minimum availability factor of 90%. Mechanical and thermal stresses and accidental mixing of Na and H_2O or steam are minimized. The steam generator consists of a superheater, boiler, and reheater section. The generator shell, designed for 200 psig pressure and fabricated of Croloy, is 72 ft – 9⅜ in. long with a shell wall ½ in. thick. The ID is 149 in. (For details see TID-4100 Suppl. 47) (F.S.)

40300 THEORETICAL CONSIDERATIONS, DESIGN, AND EVALUATION OF A CASCADE IMPACTOR. Cohen, Jerry J. (Univ. of California, Livermore); Montan, Donald N. Amer. Ind. Hyg. Ass. J., 28: 95-104(Mar.-Apr. 1967).

A cascade impactor of the multijet, round-hole design was developed that provides easy alteration of impactor stages and variation of air flow. The instrument was evaluated by empirical observation, correlation of mass distributions of aerosols as determined with the impactor versus membrane filter samples, determination of stage efficiencies, and case loss studies. (auth)

40301 PRINCIPLES OF AN INSTRUMENTED SYSTEM FOR SAFEGUARDING FISSILE MATERIAL FLOW IN THE PEACEFUL SECTOR OF NUCLEAR ENERGY. Gupta, D.; Haefele, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomkernenergie, 13: 229-36(1968). (In German).

The importance of safeguarding the fissile materials in peaceful sector has increased considerably with the increasing commercialization of nuclear energy. The presently existing international safeguards systems, as practiced by the IAEA (International Atomic Energy Agency) or the EURATOM (European Atomic Energy Commission) were developed during the fifties. At that time, safeguarding meant mainly the control of isolated nuclear facilities or of relatively small amount of fissile materials in countries, which had received them from the United States for scientific investigation in the peaceful sector of nuclear energy. Complete control of these facilities and materials did not infringe upon any commercial interests of such countries. The underlying principle of these safeguards systems was to control the entire peaceful sector of nuclear energy and thereby try to prevent a diversion of fissile materials to the non-peaceful sector. The only objective of any safeguards system is to prevent or to detect a diversion of fissile material for non-peaceful purposes. It is therefore, necessary to utilize only those safeguard measures which deal explicitly with the flow of fissile materials. For this purpose, a complete control of the entire peaceful sector as such is not necessary. In a commercially oriented nuclear industry the safeguard objectives are best fulfilled if only the flow of fissile material is controlled at a discrete number of strategic points in a fuel cycle. The controlling measurements and other measures should be carried out, as far as practicable, with appropriate instruments and other techniques. The system has to be executed on an international level. It should not be unduly intrusive and should not hamper the healthy growth of the nuclear industry in a country, and should function effectively. Besides this, it should in itself be economic. An international safeguards system which meets all these requirements, is highly complex and a substantial amount of research and development work is necessary before it can be properly developed. A detailed, four phase, r and d program has been worked out at the Karlsruhe research center for the development of such a system. The four phases are: phase I, system analytical investigations; phase II, development of various methods and instruments; phase III, the important system analytical results and the methods developed during phase II will be tested in industrially operating nuclear facilities; and phase IV, the final form of the safeguards system will be developed in collaboration with the industries and international control organizations. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 40289, 40293, 40299, 41421, 42391, and 42398.

40302 (ALO-3632-29) QUARTERLY PROGRESS REPORT OF RESEARCH AND DEVELOPMENT IN A THERMAL INSULATION STUDY, MARCH-MAY 1968. (Union Carbide Corp., Indianapolis, Ind. Linde Div.). Contract AT(30-1)-3632. 72p. Dep. CFSTI.

Results of long-term thermal conductivity tests are presented for insulation systems of nickel foil spaced by quartz paper, aluminum foil spaced by opacified paper, glass paper opacified with aluminum flakes, and quartz paper opacified with copper flakes. Results of an error analysis on all cylindrical thermal conductivity tests conducted to date are presented. Thermal conductivity data which have been updated to reflect the error analysis results are presented. Thermal conductivity data (Flat Plate) as a function of temperature and mechanical load are presented for the insulation systems of glass paper opacified with aluminum flakes, glass paper, quartz paper opacified with copper flakes, aluminum foil spaced by aluminum opacified paper, and aluminum foil spaced by glass paper. Empirical equations describing the above data are presented. Equations relating to the opacified paper include a preliminary assessment of the scattering properties of the materials. Results of an analytical study aimed at determining the effect of a penetration through an insulation panel are presented. Effect of the penetration (typically a thermoelectric element) on both total heat transfer, as well as on heat transfer through the individual system elements (i.e., insulation and penetration), is considered. A brief report is included on the Hastelloy-X vacuum enclosure-1400°F – 5000 psi long-term test. (J.C.W.)

40303 (CEA-R-3425) ECHANGE DE CHALEUR ET PERTE DE CHARGE DE SURFACES A AILETTES EN CHEVRONS. RESULTATS EXPERIMENTAUX EN CELLULE A TEMPERATURE DE PAROI CONSTANTE. (Heat Exchange and Pressure Drop of Herring-Bone Fin Surfaces. Experimental Cell Results at Constant Wall Temperature). (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1968. 64p. (In French). Dep.

The increase in the specific power of nuclear reactors of the gas-graphite type has necessitated the use of high performance exchange surfaces for canning the fuel (natural uranium). Experiments were carried out on cans fitted with herring-bone fins, at constant wall temperature; a flow of water at 100°C passes inside the can which is cooled externally by a flow of CO_2 at 15 bars pressure. This experimental set-up makes it possible to compare the aerothermal performances of the different cans with an accuracy of 5 per cent. The results obtained are presented in the form of a friction coefficient f_0 and mean Margoulis number M_0, as a function of the Reynolds number Re_0, this latter varying from 3×10^5 to 9×10^5. (auth)

40304 (EUR-3920) HEAT TRANSFER CRISIS WITH STEAM-WATER MIXTURES IN ROUND CONDUITS: REPRODUCIBILITY TESTS WITH DIFFERENT EXPERIMENTAL FACILITIES. Hassid, A.; Milani, A.; Ravetta, R.; Rubiera, L. (Centro Informazioni Studi Esperienze, Milan (Italy)). 1968. 76p. Dep.

A comparison is presented between heat transfer crisis data with vertical upward flow of steam–water mixtures in round tubes, obtained with different experimental plants. The experiments were carried out under the following conditions: (1) geometry: round tube ID = 2.5 cm; L = 240 cm and 160 cm; (2) specific mass flowrate: G = 40 to 380 g/cm² sec; (3) pressure: P = 30; 50; 60 kg/cm²; (4) inlet quality: $-0.30 \leq X_{in} \leq 0$. The experimental plants CISE IETI-2 and IETI-3 and SORIN high pressure facility are briefly described. The results obtained with the same test element are generally in good agreement, but under some conditions, unexplained discrepancies are evident. This is in agreement with the observations made by other researchers, with both round ducts and rod bundles. The discrepancies are analyzed and a margin of uncertainty is derived for the critical power values. (auth)

40305 (EUR-3948) UN PROGRAMMA NUMERICO PER IL CALCOLO DELLE PRESTAZIONI A CARICO NOMINALE E PARZIALE DEL GRUPPO TURBINA, ALTERNATORE, CONDENSATORE E PRERISCALDATORI IN CENTRALI A CICLO DI VAPORE CON RISURRISCALDAMENTO. (A Digital Code for Predicting Design and Part Load Performances of Central Station Reheat-Steam Turbine-Generator, Preheaters and Condenser). Endrizzi, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center. European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). 1968. 45p. (In Italian). Dep.

The code written in Fortran IV requires as input the design distribution of preheater-pressures and some design parameters of the turbine-generator and of the condenser. It can be used to calculate all values of thermodynamic interest. Part load calculation starts assigning throttle steam condition and flow, reheater outlet temperature and circulating water inlet temperature in condenser. (auth)

40306 (LA-3947) TRANSPORT OF ANISOTROPIC OR LOW-INTENSITY TURBULENCE. Harlow, Francis H. (Los Alamos Scientific Lab., N. Mex.). May 1968. Contract W-7405-eng-36. 14p. Dep. CFSTI.

Some extensions to the theory of turbulence transport, gen-

eralizing the theory to apply to flows with regions of weak turbulence or with strong departures from isotropy are described. (auth)

40307 (N-68-11912) CONTROL OF CONTAMINANTS IN LIQUID-METAL SYSTEMS. Gorland, Sol; Bilski, Raymond (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1967. 21p. (NASA-TM-X-1432). CFSTI.

The contaminant controls and cleaning procedures used in the SNAP-8 simulation loop, consisting of two sodium-potassium (NaK) loops and one mercury (Hg) loop, minimized both startup and operational problems. Mercury wetting was induced in the boiler and condenser as determined by progressive improvement in the heat-transfer performance. The degree of wetting is an indication of the system cleanliness. The boiler was conditioned in approximately 250 hours of operation without wetting additives. After 384 hours of operation, analysis of a Hg sample by a distillation method indicated no contamination. Oxide plugging in the NaK loops was minimized using the loop-entry procedures developed in the investigation. No plugs occurred because of changes of repairs that required system entry, and only minor partial plugs occurred in over 1500 hours of operation of the NaK loops. (auth)

40308 (NYO-3839-2) FLUID DYNAMICS OF DISPERSED TWO-PHASE VAPOR-LIQUID FLOW IN LUBRICANT FILMS. PARTS I AND II. Zuber, N.; Dougherty, D. E. (Mechanical Technology Inc., Latham, N. Y.). Mar. 1968. Contract AT-(30-1)-3839. 71p. (MTI-68-TR-30). Dep. CFSTI.

The governing equation has been derived for dispersed, two-phase lubrication film flow. It can be used to predict both the static and the dynamic characteristics of saturated vapor bearings. It was shown that the flow of a saturated vapor lubrication film depends on two dimensionless numbers: the standard Strouhal number S, and the phase change number N. It was shown that when the ratio N/S is small, the characteristics of a saturated vapor film should resemble those of a gas (noncondensible) film. Conversely, for large values of this ratio a significant difference is to be expected. A non-equilibrium two-phase film flow model was developed. The model postulates that evaporation and/or condensation of liquid droplets entrained in a vapor film flow is determined by the thermal driving potential of the internal droplet temperature and the local time varying surface saturation temperature of the droplets. The model is applicable to the analysis of steam lubricated bearings. A constitutive equation of condensation and/or evaporation was obtained for a two-phase film flow including the effects of a non-equilibrium change of phase. This constitutive equation combined with the field equations of the two-phase Reynolds' film flow complete the equation for the static and dynamic film pressure profiles and flow rates. The steady state, one-dimensional evaporate film flow was analyzed. This analysis identified three major thermo-hydrodynamic parameters of a wet vapor film flow: the inlet moisture fraction, the evaporation relaxation constant, and the initial droplet superheat fraction. The analysis showed the influence of these parameters upon the droplet evaporation fraction, and the film pressure profile. The dynamic effects of the inlet liquid droplet Weber number and, the thermo-hydrodynamic parameters on a wet vapor lubrication film were discussed. (J.C.W.)

40309 (RT/ING-(68)1) TEORIA DEI MOTI BIFASI LIQUIDO-VAPORE. PARTE I. (Theory of Liquid-Gas Two Phase Flow. Part I.). Basso, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 33p. (In Italian). Dep.

The scope of this study was to show that thermohydrodynamic instabilities, such as burnout, and the various two-phase flow patterns can be physically interpreted and analytically described on a thermodynamic basis, if the compressibility and the thermal expansion of the fluid are taken in account. The exact theoretical equations which make it possible to determine the critical flow conditions are derived and compared with the experimental results. In the first part of the study, the present status of fluid mechanics and vibration theory are examined with the aim of evaluating the limits of their validity, in the case of diabatic and two-phase flows, and with the view to link the developments to a more general context. (auth)

40310 THE INFLUENCE OF TEMPERATURE DEPENDENT PHYSICAL PROPERTIES ON HEAT TRANSFER IN TURBULENT FLOW OF LIQUIDS IN TUBES AT HIGH HEAT FLUX DENSITIES AND PRANDTL NUMBERS. Hufschmidt, W.; Burck, E. (EURATOM, Ispra, Italy). Int. J. Heat Mass Transfer, 11: 1041-8(June 1968). (In German).

The application of high heat flux densities requires a knowledge of the influence of temperature dependent physical properties of the fluid on the heat-transfer coefficient or the Nusselt number. It is shown that this influence can be given by a factor $(Pr/Pr_w)^{0.11}$ and that the isothermal Nusselt number ($q_h = 0$) can be represented by a theoretical relation $Nu_{OP} = [(\zeta/8)\ Re \cdot Pr/1.07 + 12.7 \cdot [\sqrt{(\zeta/8)}] \cdot (Pr^{\frac{2}{3}} - 1)]$ in the following test range: $3000 < Re < 640{,}000$; $2 < Pr < 180$; $1 < Pr/Pr_w < 28$; $q_h < 450\ W/cm^2$. The friction factor ζ of the fluid flow in the tube can be calculated by the equation of Prandtl-von Kármán. (auth) (UK)

40311 DEVELOPMENTS IN THEORETICAL AND APPLIED MECHANICS. VOLUME 3. Proceedings of the Third Southeastern Conference Held in Columbia, S. Carolina, March 31-April 1, 1966. Shaw, W. A. (ed.). New York, Pergamon Press, Inc., 1967. 788p. $34.00. (CONF-660302-(Vol.3)).

Forty-two papers were presented at the conference. A separate abstract was prepared for one paper. The remaining 41 papers, not within scope of NSA, contain information on continuum mechanics, elasticity, plates and shells, applied mechanics, experimental mechanics, wave propagation, dynamics, vibrations, and fluid mechanics. (R.C.K.)

For an abstract of the individual paper see: 40312.

40312 ANALYSIS OF AXIAL FLOW THROUGH A CIRCULAR CHANNEL CONTAINING ROD CLUSTERS. Min, T. C.; Hoffman, H. W.; Tucker, T. C.; Peebles, F. N. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). pp 667-90 of Developments in Theoretical and Applied Mechanics, Vol. 3. Shaw, W. A. (ed.). New York, Pergamon Press, Inc., 1967.

From 3rd Southeastern Conference on Theoretical and Applied Mechanics, Columbia, S. C. See CONF-660302-(Vol.3).

An accurate, approximate method for the determination of velocity, pressure drop friction factor, and shear stress for laminar flow through a circular channel containing a rod cluster is reported. This method employs a mapping function and the transformation of the complex potential from one polar coordinate system to another. Thus, the velocity may be expressed explicitly in any portion of the flow channel within the complicated physical boundaries before the boundary conditions are imposed. The boundaries are then point-matched in the least-squares sense. Solution can be obtained and ensured to any desired degree of accuracy. The treatment can be extended to problems involving such other configurations as stars, crosses, or wagon wheels commonly encountered in certain aspects of space technology. (auth)

40313 PROCEEDINGS OF THE 1968 HEAT TRANSFER AND FLUID MECHANICS INSTITUTE HELD AT THE UNIVERSITY OF WASHINGTON, SEATTLE, JUNE 17-18, 1968. Emery, Ashley F.; Depew, Creighton A. (eds.). Stanford, Calif., Stanford University Press, 1968. 281p. $10.00. (CONF-680615).

Nineteen papers were presented at the Institute. Separate abstracts were prepared for two papers. The remaining papers contain information on advances in fluid mechanics, heat transfer, and related fields not within scope of NSA. (R.C.K.)

For abstracts of individual papers see: 40314 and 41421.

40314 ANALYTICAL DESCRIPTION OF THE WAITING PERIOD BETWEEN SUCCESSIVE VAPOR BUBBLES FORMED DURING NUCLEATE BOILING. Dzakowic, G. S. (Westinghouse Astronuclear Lab., Pittsburgh); Frost, W. pp 98-115 of Proceedings of the 1968 Heat Transfer and Fluid Mechanics Institute held at the University of Washington, Seattle, June 17-18, 1968. Emery, Ashley F.; Depew, Creighton A. (eds.). Stanford, Calif., Stanford University Press, 1968.

See CONF-680615.

The waiting time between successive vapor bubbles which are nucleated from a heated surface is modeled with the view that the temperature buildup in the liquid is subject to a time varying liquid-solid surface temperature and surface heat flux. An incipient boiling criterion is combined with the transient liquid temperature solution to specify the end of the waiting period. Order of magnitude increases of the waiting time, in some cases, are predicted by the analytical result as a function of the initial temperature distribution in the heat generating material, the bulk fluid temperature, and the ratio of thermal transport properties of heater and liquid. The waiting time prediction is also presented in graphical form for typical nucleate boiling conditions and is qualitatively compared with experimental data reported in the literature. (auth)

40315 FULLY DEVELOPED TURBULENT FLOW IN A CONCENTRIC ANNULUS. Michiyoshi, Itaru; Nakajima, Tsuyoshi (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 354-9(July 1968).

An analysis of the characteristics of fully developed turbulent Newtonian flow in a concentric annulus is presented. The time-averaged velocity distribution, mixing length, eddy diffusivity and friction factor are calculated on the bases of Reichardt's

expression for the eddy diffusivity of momentum and of Nikuradse's expression for the mixing length in a circular tube. These predictions agree well with available experimental data. (auth)

40316 THEORETICAL INVESTIGATION OF SOME MASS TRANSFER PROBLEMS WITH RADIOACTIVE DECAY AND WALL REACTION. Chen, Paul Chun-yung. Raleigh, N. C., North Carolina State Univ., 1968. 181p.

Thesis.

Transport of radioactive molecules and of steam vapor through an isothermal and noncondensable gas in a containment vessel was investigated. The mass transfer problems include radioactive molecules deposited on the wall surface as a function of time, with and without steam vapor condensation, for perfect sink, imperfect sink, and changeable wall surface conditions. In formulating the boundary value problem of mass transfer, it was assumed that the molecules diffuse through the uniformly distributed gas mixture to the immediate vicinity of the wall surface where they strike and adhere to the wall. For the radioactive molecules deposited on the wall surface of a containment vessel with any shape, two generalized, three-dimensional coupled equations, one for the concentration of radioactive molecules in the gas mixture and the other for conservation of molecules in the gas mixture and on the wall surface, are transformed into one integral equation. The recursion formulas obtained from the integral equation are used for any value of wall removal coefficient and for any geometry of the containment vessel. For the case of one-dimensional parallel plates, long cylinder, and sphere without steam vapor condensation, a parametric study shows that the deposition of radioactive molecules is affected by radioactive decay, geometry, and wall reaction. The effect of radioactive decay is to shift peak values of deposition curves to earlier time for molecules with short half-lives. Effects of geometry on deposition are recognized through their corresponding eigenvalues. The effect of wall reaction, which is characterized by the wall removal coefficient, is to decrease the amount of deposition. A computer program is presented to evaluate deposition for any combination of the three effects. For deposition in the presence of condensation of steam, the mass conservation equations for radioactive molecules, steam vapor, and noncondensable gas are coupled with momentum equations. The Marker-And-Cell method of finite differences is employed to obtain solution for a geometry of parallel plates. The analysis shows that the condensing steam produces a normal convective current which increases the deposition before the peak and decreases it after the peak when compared with cases involving no condensation. (Disser. Abstr.)

40317 HEAT-PIPE PERFORMANCE IN A ZERO GRAVITY FIELD. Deverall, J. E. (Los Alamos Scientific Lab., N. Mex.); Salmi, E. W.; Knapp, R. J. Contract W-7405-eng-36. J. Spacecraft Rockets, 4: 1556-7(Nov. 1967). (LA-DC-8844).

A heat pipe is a sealed container in which a fluid is continuously evaporating and condensing, thereby establishing a two-phase system resulting in an essentially constant temperature throughout the length of the container. Heat addition into the evaporator section of the heat pipe is distributed throughout the other section by flow and condensation of vapor. Completion of the cycle is obtained with the return of the condensate to the evaporator by capillary action through a wick structure lining the container wall. Thus, large quantities of heat can be transferred with essentially no temperature difference and at a fraction of the weight of an equivalent solid heat conductor. By proper choice of fluids, heat pipes can be constructed for operating temperatures from below 0° to 2000°C; they appear to have great potential for solution of heat transfer problems in space applications. An experiment was conducted to demonstrate that a heat pipe will operate normally in the absence of gravitational forces. The necessary evidence to substantiate this fact was considered to be isothermal operation of a water heat pipe while in an earth orbit. The satellite module, in which the heat pipe was mounted, was launched from Cape Kennedy April 5, 1967, on an Atlas–Agena vehicle. (auth)

Isotope Technology

Refer also to abstracts 39980, 40250, and 42340.

40318 (AGN-8258) CONCEPTUAL DESIGN OF AN IMPLANTABLE RADIOISOTOPE POWER SOURCE FOR CIRCULATORY SUPPORT SYSTEMS. Final Technical Report. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Jan. 26, 1968. Contract AT(04-3)-368. 320p. Dep. CFSTI.

The development of a conceptual design for a radioisotope power source suitable for implantation in the human body is described. The output power (7 W) from the device is to be used for circulatory support, either to assist a damaged heart or to drive an artificial heart. The engine studied is based on the Stirling cycle but differs from the conventional Stirling engine. The piston and crank mechanism of the conventional engine are replaced by a free piston arrangement to eliminate the requirement for high performance seals and bearings and to increase the potential engine life. Power is extracted from the engine in the form of pressurized gas rather than mechanical work; this permits the use of a simple intermediate fluid and bellows arrangement to couple the engine output to the circulatory support system. The engine is fueled with about 35 W of ^{238}Pu which is encapsulated in and shielded by a tungsten alloy. An outer shield of polyethylene is provided to reduce the surface neutron dose. Waste heat from the engine is transferred to the blood stream under conditions which limit the maximum blood temperature to prevent damage to the blood. A summary of power source characteristics is presented. (auth)

40319 (ANSE-6300-014) SNAP-27 RELIABILITY MEASUREMENT PLAN. Breen, T.; Peck, I. J. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Apr. 25, 1966. Contract AT(30-1)-3535. 38p. Dep. CFSTI.

The methodology and the plans by which the reliability of the SNAP 27 Integrated Power Unit will be measured are described. The integrated test program is satisfactorily balanced in that an adequate quantity of equivalent test missions are being provided for each of the significant mission environments. Utilizing test data from the integrated test program, the IPU reliability design goal of 0.9950 has the capability of being demonstrated at a confidence level of 60 percent by April 1968. In the event that data from AEC testing of generators 14 to 18 is provided, the IPU reliability design goal will be demonstrated at the 66 percent confidence level. An Operation Time Control Plan will be implemented to evaluate the effects of thermal cycling/transients on the IPU reliability. (auth)

40320 (CEA-R-3426) LOCALIZATION OF ALPHA EMITTERS BY DAMAGE PRODUCTION IN A THIN FILM. APPLICATION TO THE STUDY OF ALPHA EMITTER DIFFUSION IN IRRADIATED SAMPLES. Houdaille, Brigitte; Perrot, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1968. 25p. (In French). Dep.

The process of recording α particles on cellulose nitrate films, called alphagraphy, is applied to the study of the diffusion of α-emitting elements in irradiated alloys. The existence of diffusion is shown by attacking the film with concentrated caustic soda after exposure. The insensitivity of the recorder to $\beta\gamma$ radiation emitted by the sample after passing in the reactor makes it possible to operate with long exposure times and to detect small diffusions. The concentration-penetration curves are drawn up after carrying out a densitometric analysis of the alphagraphs. As the cellulose nitrate is affected only by α particles of energies of between 0.5 and 4 MeV, it was first necessary to determine the yield of the recorder for α particles emitted by a thick source, i.e., whose energy varies between 0 and E_0, E_0 being the energy of the alpha emitter. The concentration C of the α-emitter, as a function of the optical density D of the alphagraphy, and of the exposure time t is given by a simple relationship: $C = (D/at)$, where a is an experimental constant determined by calibration. It depends on the nature of the cellulose nitrate, of the α-emitting element and of the alloy studied. (auth)

40321 (IAN-Q-6) PRODUCCION DE RADIOISOTOPOS EN EL REACTOR IAN-R1. (Production of Radioisotopes in the Reactor IAN-R1). Paez, E. A.; Nassiff, S. J. (Instituto de Asuntos Nucleares, Bogota (Colombia)). 1966. 49p. (In Spanish). Dep.

A compilation is given of the best known methods for the production of radioisotopes and the adaptation of these methods to the conditions available at the IAN-R1 Reactor. In the discussions it is assumed that a flux of 10^{11} neutrons/cm^2 sec is available. Methods are given for ^{131}I, ^{24}Na, ^{198}Au, ^{14}C, ^{35}S, ^{32}P, and ^{137}Cs. The production of ^{131}I as a fission product is also discussed. 64 references. (J.S.R.)

40322 (MMM-8406-1757(Vol.1)(Pt.1)) THERMOELECTRIC LEG PRODUCT SPECIFICATION (TELPS). FINAL TECHNICAL REPORT. VOLUME 1. TECHNICAL RESULTS. PART 1. Richards, J. D. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). Sept. 8, 1967. Contract AT(30-1)-3535; Subcontract 028-E22009. 282p. Dep. CFSTI.

For General Electric Co., Philadelphia, Pa. Missile and Space Div.

A program was conducted to resolve the question of variation of leg performance with time and performance. Tests were performed on N-type PbTe and P-type PbSnTe thermoelectric legs

from SNAP-27 Phase II production batches. This volume contains a description of the test specimens (test records, comparison of lot production, etc.), material characterization tests, short-term ingradient testing, variance analysis of short-term performance tests, and thermoelectric properties (S, K, and ρ). (D.L.C.)

40323 (MMM-8406-1757(Vol.1)(Pt.2)) THERMOELECTRIC LEG PRODUCT SPECIFICATION (TELPS). FINAL TECHNICAL REPORT. VOLUME 1. TECHNICAL RESULTS. PART 2. Black, Jonathan (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Oct. 15, 1967. Contract AT(30-1)-3535; Subcontract 028-E22009. 360p. Dep. CFSTI.

A test program was conducted to determine the steady-state ingradient resistance and voltage characteristics of a large statistical sampling of production SNAP-27 N- and P-type thermoelectric legs over an extended period of time (>2000 hr). The variance of the long-term ingradient performance was analyzed. (D.L.C.)

40324 (MMM-8406-1757(Vol.2)) THERMOELECTRIC LEG PRODUCT SPECIFICATION (TELPS). FINAL TECHNICAL REPORT. VOLUME 2. SPECIFICATIONS AND PROCEDURES. Richards, J. D. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). Sept. 8, 1967. Contract AT(30-1)-3535; Subcontract 028-E22009. 154p. Dep. CFSTI.

For General Electric Co., Philadelphia, Pa. Missile and Space Div.

Acceptance parameters and criteria are presented for P-type TPM 206 Lot 10 PbSnTe and N-type TPM 211 Lot 9 PbTe thermoelectric legs produced for the SNAP-27 program. Engineering values of leg parameters and the required acceptance procedures are included. Computer programs used in the reduction and analysis of TELPS data are listed. (D.L.C.)

40325 (MND-3607-239-1) SNAP 19, PHASE III. VOLUME I. POWER SUPPLY SYSTEM. Final Report. (Martin-Marietta Corp., Baltimore, Md. Nuclear Div.). May 1968. Contract AT(30-1)-3607. 172p. Dep. CFSTI.

The evolution of the SNAP-19 power supply is described. The system and its modes of operation, system performance in orbit; single generators and their performance characteristics; data on the heat source; thermoelectric conversion modules, housing, instrumentation and wiring, thermal insulation, miscellaneous components; and generator subsystem, power conditioner unit and telemetry signal conditioner unit are described. The mechanical, electrical, and thermal interfaces between SNAP-19 and Nimbus B are discussed, along with nuclear radiation and its effect on the system. The generator subsystem, power conditioner unit, telemetry signal conditioner unit, and power supply system testing are discussed. Performance criteria are given. Prototype qualification and flight acceptance testing are defined and described. Mass properties and radiation measurements are reported. Criteria for parts selection and screening, and also methods of determining, identifying and handling parts critical to successful performance are described. Failure modes and effects, demonstrated reliability and reliability predictions are discussed. The major points of the safety philosophy and the technical approach to safety are covered, with references to documents in which details are given. Descriptions of the ground support test console, power supply rack, portable monitor, capsule shipping casks, generator subsystem handling, shipping and storage equipment, technical manual preparation and verification, and generator subsystem transportation are given. Design of generator subsystem from transmissibility, thermal conductance, magnetic moments and spacecraft shroud cooling standpoints is discussed in addition to testing of the power supply system with the spacecraft and a description of launch site operations. (auth)

40326 (MND-3607-239-3) SNAP 19, PHASE III. VOLUME III. GENERATOR DEVELOPMENTAL ASPECTS. Final Report. (Martin-Marietta Corp., Baltimore, Md. Nuclear Div.). May 1968. Contract AT(30-1)-3607. 87p. Dep. CFSTI.

The purpose of SNAP-19 III Program is described. Thermoelectric couple development, component selection criteria and the module criterion are described. A description of development of advanced techniques for fuel handling, outgassing and leak testing generators is presented. Heater element and heater block development, including problems encountered and method of resolution are discussed. The configuration of generators tested, preparation for the tests and the tests; results of pre-endurance and endurance tests; evaluation of thermoelectric components and conclusions drawn from endurance tests are reviewed. Design features that provide reliability, and tests that provided reliability data are covered. The performance of Viton A as generator seals is discussed. Hot junction temperature measurement system, the problems experienced during its development and the means of problem resolution are discussed. Methods used in making neutron and gamma measurements, and spectra from these measurements are presented. The method of capsule support, problems encountered with support design and means by which problems were corrected are described. (auth)

40327 TWO NUCLEAR STUDY GROUPS RELEASE IMPORTANT CONCLUSIONS. Nucl. News, 11: No. 8, 5-8(Aug. 1968).

A feasibility study is described which was conducted to determine the desirability of transferring the AEC's uranium enrichment facilities to private industry. It was concluded that private ownership and operation of the AEC's three gaseous diffusion plants is not only feasible but also preferred to continued government operation. The existence of a profit motive under private ownership to advance the technology and reduce costs was cited as the primary reason for advocating the transfer. (R.C.K.)

40328 URANIUM ENRICHMENT: METHODS AND PLANTS. Casa, Anna F. Com. Naz. Energ. Nucl., Notiz., 14: No. 6, 49-56 (June 1968). (In Italian).

A comprehensive review is presented of the principal methods used and major plants for uranium enrichment in operation or planned. (auth)

40329 RADIOACTIVE ISOTOPES FOR RESEARCH ON MIXING AND BLENDING. Com. Naz. Energ. Nucl., Notiz., 14: No. 6, 74-8(June 1968). (In Italian).

A study of the applications of isotopes to the study of mixing and blending processes is described. (auth)

40330 TRACER EXPERIMENTS IN LARGE INSTALLATIONS. Kuyper, E. (Koninklijke/Shell Laboratorium, Amsterdam). Atoomenergie Haar Toepass., 10: 115-20(May 1968). (In Dutch).

The use of radioisotopes for process research in the oil industry is discussed. The measurement of component transport in distillation apparatus is discussed. Attention is given to possible errors, such as adsorption, delays in equilibration, and count rate statistics. Measurement of the radioactivity of earth layers is described. (J.J.t B.)

Materials Testing

Refer also to abstracts 40288, 40298, 40493, and 42389.

40331 (NP-17544) [FAST STRAINING TESTS AT 400°C ON ENRICHED ALLOY FUEL ELEMENTS]. Addendum. Martin, B. M. (Atomic Weapons Research Establishment, Aldermaston (England)). June 13, 1966. 3p. (PR/OP-53(Add.)). Dep. CFSTI. UK.

The median and standard deviation of fuel element loads to failure were determined from tests on 21 notched fuel elements to be 5070 and 250 lb, respectively. The difference between the median and the maximum design load of the pulsed reactor indicates a very remote chance of an element failing in the reactor. (D.L.C.)

40332 1968 BOOK OF ASTM STANDARDS WITH RELATED MATERIAL. PART 31. PHYSICAL AND MECHANICAL TESTING OF METALS: METALLOGRAPHY, NONDESTRUCTIVE TESTING, FATIGUE, EFFECT OF TEMPERATURE. Philadelphia, American Society for Testing and Materials, 1968. 1,065p. $19.00.

A book of standards is presented on physical and mechanical testing of metals. Standards covering the following topics are presented: calibration of mechanical testing machines, extensometers, and strain gages; corrosion of metals; effects of temperature on metals; inspection and testing agencies; mechanical tests; metallography; nondestructive testing; physical testing; radiation effects; temperature measurement; and related information. A complete subject index is included. (R.C.K.)

40333 RECENT PROGRESS IN NEUTRON IMAGING. Berger, H. (Argonne National Lab., Ill.). Brit. J. Non-Destruct. Test., 10: 26-33(June 1968).

Several novel methods for recording thermal neutron images have been investigated during recent years. These new methods offer some advantages over those methods which have been in common use. The newer methods include thermoluminescent techniques, track-etch methods in insulating sheets, and fast response motion-sensitive television systems. The characteristics of these methods are described and compared with the widely used direct exposure and transfer photographic methods for neutron image detection. (auth)

40334 LUBRICATION IN SPACE VACUUM (10^{-10} TORR). I. TESTING TECHNIQUES FOR BALL BEARINGS. Harris, C. L.; Read, J. E.; Thompson, J. B.; Wilson, C. I. (Space and Weapons Research Lab., Frimley, Eng.). Lubric. Eng., 24: 57-63(Feb. 1968).

Development of a modular-test-capsule technique for vacuum testing of dry-film and oil-lubricated ball bearings is described. This technique allows the routine achievement of bearing-environment pressures of 10^{-9} to 10^{-10} torr in the case of dry-lubricant evaluation with no possibility of cross-contamination errors. With oil and grease lubricants, ambient pressure is limited to a range from 10^{-7} to 10^{-8} torr by the vapor pressure and volatility of the lubricant present, but cross-contamination effects are again minimized by use of molecular-flow orifice plates between bearing chambers. Results of film coatings with lead proved reliable under the defined test conditions, lifetimes of from 8000 to 15,000 hr being achieved in a group of thirteen test rigs. Various other dry lubricants tested, including gold, gallium, PTFE, and molybdenum-disulphide, gave erratic results in terms of both lifetime and bearing-torque performance. Lifetimes in excess of 6000 hr at 3000 rpm have been achieved with several oils and greases in tests in which phenolic laminate retainers and lubricant reservoirs have been included. (IAA)

40335 OPERATIONAL STRESSES IN NUCLEAR PRESTRESSED CONCRETE PRESSURE VESSELS. PART I. Lewis, D. J.; Irving, J. (Central Electricity Generating Board, Berkeley, Eng.). Civil Eng. Public Works Rev., 63: 673-6(June 1968).

A description is given of the stress analysis of a nuclear prestressed concrete pressure vessel, using the "finite element" method of computation. Emphasis is placed on the long term operational behavior of the vessel, which is often not adequately considered. The long term stresses are found by a simple direct method based on the concept of "steady state" stress. The whole sequence is carried out by computer and the various programs used are briefly described. Results are shown in the form of stress contour plots, obtained by automatic machine plotting techniques. (auth)

40336 OPERATIONAL STRESSES IN NUCLEAR PRESTRESSED CONCRETE PRESSURE VESSELS. PART II. Lewis, D. J. (Central Electricity Generating Board, Berkeley, Eng.). Civil Eng. Public Works Rev., 63: 793-6(July 1968).

Example calculations are presented, together with programs used. Future computation advances are also indicated. Part 1 appeared in the June 1968 issue of the journal. (UK)

40337 BETA BACKSCATTER MEASUREMENT OF COATING THICKNESS. Melrose, S. P. G.; Cooper, B. S. (Johnson, Matthey and Co., Ltd., London). Trans. Inst. Metal Finish., 45: 199-205(1967).

The potential value of beta backscatter techniques in plating thickness measurement has long been known, but the method has not yet been widely applied. The development of reliable equipment that is simple to operate has prepared the way for its extensive use, particularly for precious metal coatings. Comparisons of backscatter intensities enable measurement of plating thickness for particular electrodeposited metal/substrate combinations to be made, the method depending for its accuracy principally on the preparation of uniform and reliable standards. Future development includes the possible use of x-ray fluorescence techniques. (auth)

40338 STRESS CORROSION TESTING. A Symposium Presented at the Sixty-ninth Annual Meeting, American Society for Testing and Materials, Atlantic City, N. J., 26 June–1 July 1966. Philadelphia, Pa., American Society for Testing and Materials, 1967. 386p. $25.00. (ASTM-STP-425; CONF-660667).

A total of twenty-two papers was presented at the conference. An abstract was prepared for one paper. Papers not abstracted are concerned with current materials testing practices and with theory as it affects methodology. Structural metals covered include high strength steels, stainless steels, and alloys of Al, Mg, and Zr. (J.R.D.)

For an abstract of the individual section see: 41005.

40339 PROCEEDINGS OF THE 1967 SYMPOSIUM ON NONDESTRUCTIVE TESTING OF WELDS, ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO, JANUARY 30, 31, AND FEBRUARY 1, 1967. Drouillard, Thomas F. (ed.). Evanston, Ill., American Society for Nondestructive Testing, Inc., 1968. 438p. (CONF-670102).

A total of seventeen papers was presented at the conference. A separate abstract was prepared for each of four papers. Papers for which no abstracts were prepared are concerned with personnel training, ultrasonic evaluation of welds, automatic inspection, transducers, imaging systems, new techniques, bond inspection using liquids, testing Saturn booster welds, discontinuities detection using liquid crystals, testing by heat transfer, laminography, and color radiography. (J.R.D.)

For abstracts of individual sections see: 40340, 40341, 40343, and 40344.

40340 NONDESTRUCTIVE TESTING IN PIPELINE CONSTRUCTION. Barkow, A. G. (Natural Gas Pipeline Co. of America, Chicago). pp 11-48 of Proceedings of the 1967 Symposium on Nondestructive Testing of Welds, Illinois Institute of Technology, Chicago, January 30, 31, and February 1, 1967. Drouillard, Thomas F. (ed.). Evanston, Ill., American Society for Nondestructive Testing, Inc., 1968.

See CONF-670102.

Although all methods of nondestructive testing have been tried, radiography is most frequently used for oil and gas pipeline construction, operation, and inspection. Radiographs are produced by x-rays and gamma-rays. Special equipment has been designed for pipeline work. Radiographs may be made with the source on the inside of the pipe and film on the outside or with the source on the outside and the film diametrically opposite and also on the outside. Visual inspection is used in all stages of construction and is considered as important as any other method. Hydrostatic pressure tests are used to prove the soundness of the completed line. This is the latest method of testing and again involves specially designed equipment. (auth)

40341 INSPECTION OF SMALL SPECIALTY WELDS AND BRAZED JOINTS FOR NUCLEAR SERVICE. McClung, Robert W. (Oak Ridge National Lab., Tenn.). pp 182-204 of Proceedings of the 1967 Symposium on Nondestructive Testing of Welds, Illinois Institute of Technology, Chicago, January 30, 31, and February 1, 1967. Drouillard, Thomas F. (ed.). Evanston, Ill., American Society for Nondestructive Testing, Inc., 1968.

See CONF-670102.

Nondestructive testing techniques have been developed and applied to the evaluation of various welded and brazed joints at ORNL. The test specimens included closure welds for fuel rods and irradiation capsules, welded thermocouples, and brazed joints for component attachment and for seals. Because of the environment to which the parts are exposed, the quality requirements have been strict. Radiography, ultrasonics, liquid penetrants, and helium leak testing have been utilized. For some of the problems it was necessary to develop jigs, mechanical devices, or ultrasonic probes to achieve the desired results. (auth)

40342 HIGH VOLTAGE RADIOGRAPHY FOR NONDESTRUCTIVE TESTING THICK WELD SECTIONS. Hafemeister, Robert N. (Allis-Chalmers Mfg. Co., Milwaukee). pp 249-69 of Proceedings of the 1967 Symposium on Nondestructive Testing of Welds, Illinois Institute of Technology, Chicago, January 30, 31, and February 1, 1967. Drouillard, Thomas F. (ed.). Evanston, Ill., American Society for Nondestructive Testing, Inc., 1968.

See CONF-670102.

Equipment and techniques used in high voltage radiographic inspection of thick weld sections (5 to 10 in.) for pressure vessels, electrical generating machinery, compressors and pumps, castings, and forgings are reviewed. Specifications, identification of defect areas, and sensitivity requirements are discussed as are x-ray units, betatrons, electron linear accelerators, cobalt 60 gamma ray units, and field radiography. (P.G.C.)

40343 LEAK TESTING OF WELDED VESSELS. Roehrs, Robert J. (Nooter Corp., St. Louis). pp 318-69 of Proceedings of the 1967 Symposium on Nondestructive Testing of Welds, Illinois Institute of Technology, Chicago, January 30, 31, and February 1, 1967. Drouillard, Thomas F. (ed.). Evanston, Ill., American Society for Nondestructive Testing, Inc., 1968.

See CONF-670102.

Factors affecting soundness of welds in pressure vessels, nomenclature in the field of leak testing, modes of flow, and associated problems connected with the flow of fluids in leaks are discussed. The methods for tracing leaks described include use of tracer gases, sensitivity variables, hydrostatic testing, pneumatic tests, visual testing, dye penetrant tests, smoke bomb testing, displacement testing, chemical reaction testing, bubble testing, infrared, thermal conductivity, ionization gage testing, helium mass spectrometry, radioactive isotope, and high vacuum testing. (P.G.C.)

Protective Structures

40344 (AD-668220) ANALYSIS OF ROOF WASHDOWN VERSUS APPLIED SHIELDING AS A FALLOUT COUNTERMEASURE. Lee, Hong (Stanford Research Inst., Menlo Park, Calif.). Dec. 1966. Contract N00228-66-C-0231. 41p. CFSTI.

Basic applicability and relative worth of roof washdown as a fallout radiation countermeasure are evaluated. The basic purpose of roof washdown is to reduce the radiation dose to occupants of a building by preventing or reducing the accumulation of fallout on the roof. However, the roof washdown system does

not affect the penetration of the roof by radiation from other sources. It was found that under some circumstances a roof washdown system is a useful means for increasing the protection of building interiors and that, in general, the cost of a washdown system for large roof area structures with smooth sloped roofs will be less than the cost of providing an equivalent amount of shielding. However, applied shielding provides 100 percent reliability whereas roof washdown systems may not be as reliable. (auth) (USGRDR)

40345 INVESTIGATION OF THE CREEP OF FUEL-ELEMENT CANS UNDER INTERNAL PRESSURE USING A DAMAGE-FUNCTION CREEP THEORY. Blackburn, W. S. (International Research and Development Co., Ltd., Newcastle-upon-Tyne, Eng.). J. Strain Anal., 3: 170-5(July 1968).

The creep deformation of an internally pressurized fuel can in the presence of superposed cyclic thermoelastic stresses was investigated. The period of significant primary creep is comparable with that of the cycle. Hence it is necessary to develop a more complex theory than that of time or strain hardening. The simplest of such theories based on dislocation behavior, but in which the material parameters may be determined from simple experiments, was chosen. For an austenitic steel this theory gave good agreement with both creep and relaxation tests. It was applied therefore to the problem of the fuel can. It was found that in practice the increased damage caused by the cycling over-compensated for the effect of the increased stress so that the material did not deform as much as when there was no cycling. (auth) (UK)

Radioactive Material Handling

Refer also to abstracts 40030, 40153, 40286, and 42168.

40346 (CONF-660345-1) TECHNISCHE UND RECHTLICHE FRAGEN DER ENDBESEITIGUNG RADIOAKTIVER ABFAELLE. (Technical and Legal Problems of the Final Disposal of Radioactive Wastes). Schwibach, J. ([Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany)]). [1963]. 16p. (In German). Dep.

From Meeting on the Final Removal and Deep Storage of Radioactive Residues, Essen, Germany.

The early American efforts in the final disposal of radioactive wastes are outlined. The American emphasis has been on burial. The beginning of nuclear development in Germany is outlined. The German regulations for the disposal of radioactive wastes are critically evaluated. The German research program for the disposal of radioactive wastes and residues is examined in some detail. Initial efforts were on the deposition of these wastes in underground salt formations. Sinking the radioactive wastes in sealed containers in the Atlantic has also been investigated. (J.S.R.)

40347 (DP-1135) CONCENTRATION OF RADIOACTIVE WASTES. Goodlett, Claude B. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1968. Contract AT(07-2)-1. 36p. Dep. CFSTI.

Radioactive wastes from the processing of irradiated fuel elements can be reduced to an immobile concentrate with about ½ of its original volume by one or more successive evaporations of the decantable liquid. During these concentrations the ^{137}Cs content increases ~17-fold. The concentrate can be remobilized at rates exceeding 0.1 ft/hr, if necessary, by the addition of water. (auth)

40348 (DP-1136) TRANSFER OF RADIOACTIVE SLURRIES. Goodlett, Claude B. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1968. Contract AT(07-2)-1. 35p. Dep. CFSTI.

Slurries of radioactive waste carrying up to 20 vol % undissolved solids can be pumped through extensive horizontal runs of 2-inch pipe, if the bulk velocity is at least 1.6 ft/sec. A vertical submerged pump with an overhung shaft and a special casing is used. (auth)

40349 (DP-1140) PERFORMANCE OF A CENTRIFUGAL MIXER-SETTLER AS A PHASE SEPARATOR. Goodlett, C. B. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1968. Contract AT(07-2)-1. 28p. Dep. CFSTI.

A single centrifugal mixer-settler used as a separator provides endstreams containing less than 0.5% entrainment when fed a thoroughly mixed emulsion at feed rates up to 25–30 gpm. The capacity of the unit exceeds 40 gpm if the phases are partially settled prior to feeding the separator. (auth)

40350 (NYO-2539-8) STRUCTURAL INTEGRITY OF SHIPPING CONTAINERS FOR RADIOACTIVE MATERIALS. PART IX. TEST OF SETTLING OF LEAD SHIELDING DUE TO END IMPACT. Clarke, H. G. Jr.; Carfagno, S. P. (Franklin Inst. Research Labs., Philadelphia, Pa.). Jan. 1968. Contract AT(30-1)-2539. 28p. (I-A-2412-9). Dep. CFSTI.

Two small-scale models of radioactive shipping containers were subjected to impact tests to investigate lead settling. Appreciable settling could result in an unacceptable local loss of shielding. The lead was unbonded in one model and partially bonded in the other. The models were dropped from a height of approximately 30 feet onto a massive steel anvil, the models oriented to strike flat on their bottoms. The lead settled a distance equal to a few percent of its initial height in the unbonded model and less than one percent in the partially bonded model. The lead settling created high radial forces that caused bulging of the outer shell, but no fractures resulted. (auth)

40351 (ORNL-3803) PILOT PLANT STUDIES OF THE DECONTAMINATION OF LOW-LEVEL PROCESS WASTE BY A SCAVENGING-PRECIPITATION FOAM SEPARATION PROCESS. King, L. J.; Shimozato, A.; Holmes, J. M. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 57p. Dep. CFSTI.

The Scavenging-Precipitation Foam-Separation process for treating low-level radioactive waste water was studied on a pilot plant scale. Processing rates of 300 gph for scavenging precipitation and 120 gph for foam separation were achieved. The process consists in precipitating calcium, magnesium, and radionuclides in a sludge-blanket clarification step that includes the use of Grundite clay for sorption of cesium, and achieving further decontamination in a 2-ft-square by 8-ft-high countercurrent foam column. It was more difficult to generate a stable foam in the pilot plant foam column than it was in the smaller columns used for laboratory and engineering studies. Pall rings were installed in the foam section to prevent circulation of the foam, and a much higher concentration of surfactant was used in the liquid pool at the bottom of the column than was used previously for the smaller columns. The use of the parameter $V/L\bar{D}$ (where V and L are gas and liquid flow rates, respectively, and $\bar{D}$ is the average bubble diameter) as a basis for process control appears valid for a large system even though the foam contains bubbles that vary widely in size. In a 93-hr test of the entire process at steady state, using ORNL low-level process waste as feed, the overall strontium decontamination factor was 1050. This concentration of strontium in the treated waste was 2.3% of the MPC_w (168-hr). The SPFS process does not appear to be economically competitive with other low-level waste treatment processes. A preliminary cost study indicated that a more efficient foam contactor must be developed to increase processing rates and decrease airflow requirements, and increased volume reduction and more economical foam-breaking methods are needed. (auth)

40352 LEGAL AND POLITICAL ASPECTS OF THE CONTROL OF INTERNATIONAL TRADE IN NUCLEAR FUELS. PART I. Tournes, Hubert. Rev. Fr. Energ., 18: 219-4(Mar. 1967). (In French).

The term "nuclear fuel" constitutes a chain in which the poorest uranium or thorium ores are the first link and almost pure fissile material the last. The international commerce in nuclear fuels which began in 1950 with the contracts signed for the purchase of ores, is briefly summarized. The possible future development of international commerce in nuclear fuels is discussed. The legislation of the United States and of Euratom to control sale of nuclear fuels is summarized. (J.S.R.)

40353 LEGAL AND POLITICAL ASPECTS OF THE CONTROL OF THE INTERNATIONAL COMMERCE IN NUCLEAR FUELS. PART II. Tournes, Hubert. Rev. Fr. Energ., 18: 271-81(Apr. 1967). (In French).

The transfer of nuclear fuels is considered. The exigencies of international security which have led to the control of the commerce are outlined. The supply conditions relative to the use of nuclear fuels are discussed in detail. The condition of peaceful usage, acceptance of a control of the utilization, and the usage condition are defined. (J.S.R.)

40354 LEGAL AND POLITICAL ASPECTS OF THE CONTROL OF THE INTERNATIONAL COMMERCE IN NUCLEAR FUELS. PART III. Tournes, Hubert. Rev. Fr. Energ., 18: 432-40(June 1967). (In French).

The international mechanisms controlling the exchange of nuclear fuels are analyzed. Both bilateral and multilateral agreements are discussed. (J.S.R.)

40355 ON THE NEW REGULATIONS FOR THE TRANSPORT OF RADIOACTIVE MATERIALS IN THE G.D.R. Richter, D. (Staatliche Zentrale fuer Strahlenschutz, Herrenleite, Ger.). Isotopenpraxis, 4: 37-40(Jan. 1968). (In German).

The areas of concern of the new regulations for the transport of

radioactive materials are summarized. The packaging required, the limitations on the content of radioactive material and the external radiation, and the specifications placed on the transport are described. The authorizations needed and the special regulations governing the various types of transportation are given. (J.S.R.)

40356 COMPUTER PROGRAM FOR DETERMINATION OF THE SHIELDING OF URANIUM FISSION PRODUCTS. Rohloff, F. (Kernforschungsanlage, Juelich, Ger.). Atompraxis, 14: 2p. (June 1968). (In German).

A computer program was developed for calculation of dose rates from spent fuel elements and the shielding required. Input parameters are given, including operation data for the reactor, cooling time, and configuration of the shielding. (tr-auth)

Vacuum Engineering

Refer to abstract 40334.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 40320, 40494, 41395, 42019, and 42383.

40357 (CEA-R-3304) DETECTION DES NEUTRONS PAR SEMI-CONDUCTEUR DANS UN COEUR DE REACTEUR ATOMIQUE. (Neutron Detection in an Atomic Reactor Core Using Semi-Conductors). Divoux, Francois (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 1968. 72p. (In French). Dep.

The principle of nuclear particle detection by semiconductor diodes is described. Fabrication of the semiconductor device used to estimate thermal neutron fluxes in the core of a swimming pool-type reactor is discussed. The useful volume (2.9 mm thickness) is in the light water moderator, between fission element plates. The results, principally obtained in the core of the Siloette reactor at the Centre d'Etudes Nucléaires de Grenoble at low power, are presented. Flux maps are included and comparison between converter products boron-10, lithium-6, and uranium-235 is made. (auth)

40358 (IAN-RS-ERA-2) CALIBRACION DE DETECTORES DE CENTELLEO. (Calibration of Scintillation Detectors). Hernandez, J. A.; Tejada, M. C. (Instituto de Asuntos Nucleares, Bogota (Colombia). Seccion Estudio Radiometrico Ambiental). 1968. 39p. (In Spanish). Dep.

A fast scintillation method for calculating the efficiency of a scintillation detector is described. The procedure is limited to integration of the differential spectrum obtained for various samples and to calculation of the efficiency of the crystal for measurement of an expression deduced on the basis of the decay scheme of the radioisotope. The efficiency thus obtained is presented in graphs as a function of the energy for each of the scintillators. An approximation method is then presented for calculation of the resolution of a detector. Various methods and a nomogram for the rapid determination of the activity of a sample are given. (tr-auth)

40359 (INP-605/PL) SCYNTYLACYJNY DETEKTOR PROMIENIOWANIA β^+ REJESTRUJACY KOINCYDENCJE ANIHILACYJNYCH KWANTOW GAMMA. (Scintillation Detector for β^+ Radiation Registering Coincidences of Annihilation Gamma Quanta). Pomorski, L.; Wilczynski, J. (Institute of Nuclear Physics, Krakow (Poland)). Apr. 1968. 15p. (In Polish). Dep.

A coincidence detector for β^+ radiation which registers scintillations of annihilation gamma rays to be used in the activation analysis by ^{3}He ions of low energy was constructed. A brief technical description of this arrangement is given. The efficiency of β^+ detection is 1.4%, and the background is 0.7 counts per minute. (auth)

40360 (JINR-P13-3894) QUENCHING OF LIGHT FLASHES IN THE LIQUID SCINTILLATORS BY A DECAYING ELECTRICAL FIELD. Zhil'tsova, L. Ya.; Matveeva, E. N.; Medvedev, M. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 8p. (In Russian). Dep.

The results of the experiments on the quenching of light flashes in the liquid scintillators with the help of a decaying electrical field have been given. (auth)

40361 (SLAC-Trans-84) A NEW DETECTOR FOR RELATIVISTIC PARTICLES. Lorikyan, M. P. Translated by Robert Addis for Stanford Linear Accelerator Center, Calif., from Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 376-9(1967). 4p. Dep. CFSTI.

A single-particle detector in which use is made of KCl and CsI films and either an electron multiplier or solid-state detector for secondary-electron emission is described. (B.G.D.)

40362 PROBLEMS IN MEASURING WEAK BETA RADIATION BY LIQUID SCINTILLATION COUNTING AND THE COUNTER TYPE NZ-137, DEVELOPED FOR THIS SPECIAL PURPOSE. Desi, S. (Gammawerken, Budapest). Atompraxis, 14: 247-9(June 1968). (In German).

The advantages of the fast-pulse measuring techniques as they are used in the NZ-137 type liquid scintillation measuring apparatus, are discussed as an effective method for reducing the background counting rate, originating either from photomultiplier thermal noise, or from the phosphorescence of the measuring cuvettes. Due to a common application of this method together with the up-to-date multi-alkali photocathode photomultipliers, the sensitivity of the single-channel liquid scintillation measuring devices will greatly increase and may become comparable with the sensitivity of the coincidence type equipment. (auth)

40363 APPLICATION OF NUCLEAR EMULSIONS IN THE FIELD OF LOW ENERGY NUCLEAR PHYSICS. pp 499-514 of Sixth International Conference on Corpuscular Photography, Florence, July 19-23, 1966. Della Corte, M. (ed.). Roma, Edizioni C.E.P.I., 1966.

Topics discussed include the measurement of neutron spectra by the lithium-6(n,t) helium-4 reaction using nuclear emulsion techniques and surface-barrier detectors, the use of charged emulsions for studying fission and fragmentation, and the use of nuclear emulsions for studying energy spectra and probability of emission of alpha particles in fission. (W.H.K.)

40364 DETECTION OF TRACKS IN SOLID MATERIALS. pp 427-98 of Sixth International Conference on Corpuscular Photography, Florence, July 19-23, 1966. Della Corte, M. (ed.). Roma, Edizioni C.E.P.I., 1966.

Topics discussed in the 10 papers of this section include recent developments in solid state track detectors; fission-fragment detection using mica, platinum foils, and acetylcelluloid foils; fast neutron flux measurements using plastics; charged-particle track formation in organic polymers; particle energy measurement according to diameter of holes in track detectors; and charged-particle tracks in single crystals of silver chloride. (W.H.K.)

40365 APPLICATIONS OF NUCLEAR EMULSIONS. pp 313-426 of Sixth International Conference on Corpuscular Photography, Florence, July 19-23, 1966. Della Corte, M. (ed.). Roma, Edizioni C.E.P.I., 1966.

Applications of nuclear emulsions in high-energy research are discussed in the 17 papers in this section. These applications include cosmic radiation studies, particle interactions, geophysical phenomena, nuclear spallation, and use as a detector in experiments using future high-energy accelerators. (J.F.P.)

40366 UTILIZATION OF NUCLEAR EMULSIONS COUPLED WITH OTHER TECHNIQUES. pp 261-312 of Sixth International Conference on Corpuscular Photography, Florence, July 19-23, 1966. Della Corte, M. (ed.). Roma, Edizioni C.E.P.I., 1966.

The six papers in this section cover nuclear emulsion in hyperfragment studies, disintegration of heavy hyperfragments produced by 800-MeV/c K, hyperfragments in Σ^--at-rest capture stars, a $\Lambda\Lambda$-He^6 double hyperfragment, ionographic emulsions and plastic ionographic detectors, and determination of small thicknesses of photographic emulsions by energy loss of alpha particles measured using semiconductor detectors. (J.F.P.)

40367 AUTOMATION OF MEASUREMENTS ON TRACKS IN NUCLEAR EMULSIONS. pp 173-260 of Sixth International Conference on Corpuscular Photography, Florence, July 19-23, 1966. Della Corte, M. (ed.). Roma, Edizioni C.E.P.I., 1966.

Recent developments in optical and electron microscope techniques for measuring charged-particle tracks in nuclear emulsions are discussed. Also, the development of nuclear emulsions for electron autoradiography is described. Eleven papers are included in this section. (W.H.K.)

40368 PROPERTIES OF NUCLEAR EMULSION. pp 15-171 of Sixth International Conference on Corpuscular Photography, Florence, July 19-23, 1966. Della Corte, M. (ed.). Roma, Edizioni C.E.P.I., 1966.

Topics discussed in the 21 papers of this section include theoretical aspects of the preparation of nuclear emulsions, neutron activation analysis of latent images, sensitivity of nuclear emulsions, substitution of synthetic polymers for gelatin in nuclear emulsions, sensitizing of nuclear emulsions, particle track distortions due to processing technique, and detection of fission fragments with nuclear emulsions. (W.H.K.)

40369 SIXTH INTERNATIONAL CONFERENCE ON CORPUSCULAR PHOTOGRAPHY, FLORENCE, JULY 19-23, 1966. Della Corte, M. (ed.). Roma, Edizioni C.E.P.I., 1966. 522p. (In Several Languages). (CONF-660713).

Sixty-eight papers on nuclear emulsions and solid state particle track detectors are presented. The papers are divided into six sections, by topics, and separate abstracts were prepared for each of the six sections. (W.H.K.)

For abstracts of individual sections see: 40363—40368.

40370 DETECTION OF NEUTRONS WITH THE ETCH-PIT COUNTING METHOD. Nishiwaki, Yasushi (Tokyo Inst. of Tech.);

Kawai, Hiroshi. Hoken Butsuri, 3: 201-7(Mar. 1968). (In Japanese).

Fission fragments mark scars on such an insulator as glass or mica, when fissions take place on the surface of or inside the insulator material. Very small scars on the surface of the insulator material caused by the fission fragments can be etched by the suitable chemical treatment to form etch-pits visible under the ordinary microscope. Therefore the combination of the fissionable material and the insulator material can be used for neutron detection or neutron dosimetry. Thin films of uranium or thorium electrodeposited on gold foil were used as the fissionable material and the glass or mica as the detector material of the fission fragments. The thin film of the fissionable material was kept in contact with the surface of the glass or mica. The effect of the different etching condition and the stability of the scars have been studied. It has been shown by the fission film-glass or mica combination that a good agreement exists between the expected number of fissions and the number of etch-pits. Distribution of thermal neutron flux in the reactor (UTR-B) was estimated with this system. The results of the etch-pit counting were in good agreement with those estimated with the activation method. A wide range of thermal neutron dose 10 mrem to 1000 rem may be measured with a single detector of this type with reasonable accuracy. (auth) (NSA of Japan)

40371 DEVICE FOR MEASUREMENT OF LOW CONCENTRATION BETA-ACTIVE GASES. Khristova, Margarita; Mishev, Iliya. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 165-9(1968). (In Russian).

A measuring device for beta-active gases with six counters CTC-6 is constructed and investigated. The proposed device provides measurement of $0.6 \cdot 10^{-11}$ Ci/l concentration of argon-41, with reliability 95% and a statistical error of 30%. (auth)

40372 CALIBRATION METHOD FOR THORON MEASURING DEVICES. Hoehle, R.; Wetzstein, E. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Atomkernenergie, 13: 285-7(1968). (In German).

Calibration problems of thoron measuring devices for protection control are caused by an inaccurate knowledge of the specific activity of thoron for the gas flow used for calibrating. A method is described for calibrating thoron measuring devices based on the principle of the double-filter and giving an exact specific activity of thoron for the gas flow used for calibration. It is reached without the use of calibrated solutions of thorium. The measuring results obtained in the range from 10^{-8} to 10^{-9} Ci/l of specific activity of thoron are in good agreement with predetermined values. (auth)

40373 NEUTRON MONITOR, GRAPHITE-MODERATED (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1750).

A high-efficiency graphite-moderated neutron counter is described which is used with weak neutron sources in the presence of high γ activity. The counter consists of forty $^{10}BF_3$ proportional counters imbedded in a graphite cylinder. The system is surrounded by water on all sides to act as a reflector and shield, and is operated with the neutron source placed at the center. The configuration consists of a hexagon matrix of individual counters forming five rings parallel to the cylindrical axis. Measured total efficiency is ~60% and nearly independent of energy. Relative efficiency among rings is energy dependent. (For details see TID-4100 Suppl. 47). (F.S.)

40374 LIQUID SCINTILLATION COUNTING USING EXTERNAL STANDARD AND CHANNELS RATIO TECHNIQUES FOR QUENCH CORRECTION. Bell, T. K. (Royal Victoria Hospital, Belfast). Lab. Pract., 17: 809-12(July 1968).

A guide to techniques for quench correction associated with liquid scintillation counting using external standard and channels ratio methods is presented. (auth) (UK)

40375 EQUIPMENT FOR MEASURING RADIOACTIVITY AS DISCHARGED IN THE FORM OF EFFLUENTS. Rainbault, Pierre; Goupil, Jean; Marque, Yves (to Commissariat a l'Energie Atomique). U. S. Patent 3,389,251. June 18, 1968. Priority date June 24, 1963, France.

A system of flowmeters and radiation detectors for measuring the total radiation confined in a group of effluent deactivation storage tanks is described. The data are analyzed by a computer which calculates the total activity of effluents. (W.H.K.)

40376 FAST NEUTRON DOSIMETRY BY $^{238}U(n,2n)$ REACTION TOGETHER WITH THERMAL NEUTRON DOSIMETRY BY $^{238}U(n,\gamma)$ REACTION. Sakanoue, Masanobu; Matsuura, Masataka; Saeki, Masakatsu (Kanazawa Univ., Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 265-70(June 1968).

The fast neutron flux in the central thimble of a TRIGA-II reactor was estimated by using the $^{238}U(n,2n)^{237}U$ reaction as flux monitor. The thermal neutron flux also was estimated by $^{238}U(n,\gamma) \rightarrow {}^{239}Np$ and $^{232}Th(n,\gamma) \rightarrow {}^{233}Pa$ reactions. The latter flux was further measured at the same time by γ-ray spectrometry of the product nuclides and by chemical separation and β counting with α emitting isotopes as tracer. The values of flux thus obtained were compared with those estimated from the amounts of ^{28}Al, ^{27}Mg and ^{24}Na respectively produced by the (n,γ), (n,p) and (n,α) reactions on ^{27}Al. Furthermore, for the first time, the effective cross section for the $^{238}U(n,2n)^{237}U$ reaction was estimated to be 2.8 b from a comparison with that for the $^{27}Al(n,\alpha)^{24}Na$ reaction. (auth)

40377 LINEAR SCANNING OF SMALL ANIMALS BY AN ISOTOPE SCANNER. Ramanathan, P.; Ganatra, R. D.; Mehta, M. N.; Patel, M. C.; Sharma, S. M. (Bhabha Atomic Research Center, Bombay). Int. J. Appl. Radiat. Isotop., 19: 601-2(July 1968).

It is possible to study the distribution of a radionuclide in the body of an animal at different time intervals by serial profile scanning, but it is not possible for many of the small laboratories to afford a suitable profile scanner for such studies. In this communication, a method of obtaining serial profile scans in small laboratory animals with a conventional dot scanner is described, thereby eliminating the expense of additional equipment. (auth) (UK)

40378 METHODS OF MEASUREMENT AND DISPLAY OF A TIME-VARYING HYDROGEN ATOM ENERGY SPECTRUM OF ENERGY BETWEEN 2 keV AND 1 MeV. Bernstein, W.; Cole, A.; Coupland, J.; Dubery, P.; Shepherd, V.; Sweetman, D. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., E, 1: 741-4(July 1968). (CLM-P-145).

A method is described of measuring the energy distribution of fast neutral atoms emitted from a plasma. Three methods of display are used, either separately or simultaneously, to provide a time resolved display of pulse height, spectra integrated over predetermined periods, and continuous display of count rate in a given energy interval. The energy range from 2 to 80 keV is covered by a spectrum analyzer which is described, and for the energy range from 80 keV to 1 MeV conventional scintillator techniques are used. Count rates of up to 2×10^4 particles per second may be handled. (auth)

40379 PENETRATION EFFECTS IN WIDE APERTURE COLLIMATORS. Bell, T. K. (Royal Victoria Hospital, Belfast); Johnston, A. R. Phys. Med. Biol., 13: 401-12(July 1968).

The problem of penetration of γ-rays through wide aperture cylindrical collimators, placed close to a body organ for radioisotope uptake studies, is examined. Values for the penetration factors are numerically computed for axial point sources and compared with those given by the radius-independent formulae, normally used, to establish criteria for the use of these formulae. Penetration factors were also measured experimentally, and within the limitations of the experimental method, there was good agreement with the computed values, even for sources close to wide aperture collimators. (auth) (UK)

40380 AN INFLATED BALLOON IONIZATION CHAMBER FOR LOW ENERGY, LOW LEVEL X-RAY EXPOSURE MEASUREMENTS. Kemp, L. A. W.; Read, L. R. (National Physical Lab., Teddington, Eng.). Phys. Med. Biol., 13: 451-4(July 1968).

In response to a commitment to produce secondary standard devices for the calibration of field instruments at protection levels, a prototype large-volume ionization chamber was devised to deal with the lower end of the x-ray energy range to be covered. The chamber is sufficiently robust for field use, and a smaller version may have applications in the diagnostic x-ray field. The principal constructional features of the chamber and its main characteristics are described, together with the typical performance attainable. The basic novelty involved is the use—as the chamber wall—of a thin-walled version of a so-called "rebreathing bag," as used in anaesthetics. (auth) (UK)

40381 DIGITAL DATA LOGGING TECHNIQUE FOR MEDICAL RADIOISOTOPE SCANNERS. Kemplay, J. R. (Royal Postgraduate Medical School, London). Phys. Med. Biol., 13: 413-20 (July 1968).

A method whereby information can be recorded during medical radioisotope scanning is described. The technique enables the position of each dot of the scintiscan to be recorded on punched paper tape in computer compatible form. A digital derandomizer is shown to be an economical way of allowing the data logging system to record randomly occurring information, without the usual loss attributable to the dead-time of the system. (auth) (UK)

40382 DETECTION OF FAST NEUTRONS WITH NaI(Tl) CRYSTAL. Inada, Tetsuo (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 287-91 (June 1968).

An attempt was made to use NaI(Tl) crystals as fast neutron detectors in conventional time-of-flight apparatus. Typical pulse height distributions, in the γ-ray energy range below 1 MeV, produced by the incidence of fast neutrons, are presented. The characteristics of this neutron detection system have been studied, using pulsed neutrons from the T(p,n) and D(d,n) reactions. Neutron detection efficiency curves are presented, covering both whole γ-rays and those from a few low excited levels of ^{127}I. The detection bias can be stably set at the first excitation energy (58 keV), which is lower than possible for an organic scintillator. (auth)

40383 THE RESPONSE OF PHOTOGRAPHIC EMULSIONS TO ELECTRONS IN THE ENERGY RANGE 7 TO 60 keV. Burge, R. E.; Garrard, D. F.; Browne, M. T. (London Univ.). J. Phys., E, 1: 707-14(July 1968).

The large-area responses of ten emulsions (five "conventional," three nuclear research and two Schumann-type) were examined for electron energies between 7 and 60 keV. The responses are considered in terms of the initial slope of the optical density D/exposure E curve, the value of E for D = 1, the saturation density D_s and the number of grains rendered developable per incident electron. For high D/D_s values the forms of the experimental (D,E) relationships were found to depart from those expected if the mechanism of rendering developable a photographic grain were a simple single hit process, in a way that depends on the electron energy. The effect on the single hit relationship of the dependence of the exposure on the depth of electron penetration is considered, allowing a more complete interpretation of the shape of the (D,E) curves in terms of simple descriptions of electron–grain interactions. The high sensitivities of the nuclear and Schumann emulsions make feasible the direct recording at useful magnifications of electron images formed by low energy electrons. (auth)

40384 THE RESOLUTION OF PHOTOGRAPHIC EMULSIONS FOR ELECTRONS IN THE ENERGY RANGE 7 TO 60 keV. Burge, R. E.; Garrard, D. F. (London Univ.). J. Phys., E, 1: 715-22 (July 1968).

The quality of images recorded photographically with electrons of energies from 7 to 60 keV was examined by measurements on the granularity of large areas of a number of commercial emulsions exposed to a uniform optical density and the density profiles found in the images of sharp opaque edges. The detective quantum efficiencies were evaluated from the granularity measurements for all these emulsions. A comparison between observed and calculated values of the granularity showed reasonable agreement allowing for the assumptions made. Edge density profiles were measured at 60 and 7 kV and, after the profiles were fitted to a function of exponential form, the corresponding modulation transfer functions were considered. Interrelating the measurements on the image granularity and the MTF allowed determination of the minimum detectable density difference corresponding to a Fourier image component of a given wavelength. (auth)

40385 SEMICONDUCTOR PARTICLE DETECTORS: A REASSESSMENT OF THE FANO FACTOR SITUATION. Klein, Claude A. (Raytheon Co., Waltham, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 214-25(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The problems dealt with concern the production of electron-hole pairs in a semiconductor nuclear radiation sensor. The goal is to develop a semiphenomenological model capable of describing the present experimental situation from the standpoint of yield, variance, and bandgap dependence. It was assumed that ϵ, the average amount of radiation energy consumed per pair, can be accounted for by a sum of three contributions: the intrinsic bandgap (E_G), optical phonon losses $r(\hbar\omega_R)$, and the residual kinetic energy $(^3/_2)E_G$. Both the bandgap and the temperature dependence of pair-creation energies conform to this model and suggest that optical phonon losses remain essentially constant [$0.5 \leq r(\hbar\omega_R) \leq 1.0$ eV]. Fano-factor variations are found to reflect the relative weight of phonon losses [$\chi = r(\hbar\omega_R)/E_G$], but residual energy fluctuations govern the statistical behavior for $\chi^2 \lesssim 0.3$; an application to Ge detectors yields good agreement with the best measurements available ($F \approx 0.13$). Finally, it is shown that materials such as Si or CdTe ($1.0 \leq E_G \leq 1.5$ eV) provide optimized media in terms of the ultimate resolution capability. (auth)

40386 PREPARATION OF STABLE COUNTERS BY MEANS OF COMPENSATING GERMANIUM WITH RADIATION PRODUCED STRUCTURAL DEFECTS. Ryvkin, S. M.; Makovski, L. L.; Strokan, N. B.; Subashieva, V. P.; Khusainov, A. Kh. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 226-31 (June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Characteristic features of obtaining a strong electric field in p-n-n′ structures under conductivity compensation by deep levels were discussed. The capacity behavior of such structures and methods of measuring the lifetimes of current carriers were described. (auth)

40387 SEMICONDUCTOR COUNTERS WITH THIN WINDOW n^+ AND p^+: CONTACTS PRODUCED BY ION-IMPLANTATION. Meyer, O. (Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 232-8(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Ion-implantation techniques were used to produce n^+ and p^+-contacts on n and p-type germanium, n and p-type silicon and lithium-compensated germanium. Interstitial and substitutional doping behavior of 33 elements were investigated. Only with few ions it is possible to get non-injecting contacts with good reverse characteristics using low temperature annealing process. Results on the application of those contacts to radiation detection are given. (auth)

40388 POSITION-SENSITIVE SEMICONDUCTOR PARTICLE DETECTORS FABRICATED BY ION IMPLANTATION. Laegsgaard, E. (Aarhus Univ., Demark); Martin, F. W.; Gibson, W. M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 239-45(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The advantages and problems associated with the use of ion implantation for the fabrication of position-sensitive particle detectors are discussed. Analysis of the noise and pulse rise-time properties of such devices shows the desirability of using a high sheet resistance in the distributing resistive layer for optimum position resolution while restricting the RC of the detector to values approximately equal to the clipping times used in the measuring circuits in order to obtain good position linearity. From both detector noise and pulse rise-time considerations, it is found desirable to use equal pulse shaping in the energy and the position signal measuring systems. Detectors were made by implantation of 60 keV boron and phosphorus ions into 4000 ohm-cm n-type silicon. Representative results are shown for a 4×32 mm^2 one dimensional detector which shows integral and differential position nonlinearity of less than one percent and position resolution of less than 0.2 mm. Extension to one dimensional detectors up to 50 mm and to 10×10 mm two dimensional detectors is discussed. (auth)

40389 DEVELOPMENT OF A GERMANIUM AVALANCHE-TYPE SEMICONDUCTOR NUCLEAR PARTICLE DETECTOR AND DISCUSSION OF AVALANCHE DETECTOR ARRAYS. Hutch, Gerald C.; McKinney, Russell A.; Locker, Robert J. (General Electric Co., Philadelphia). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 246-57(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Research on avalanche or high field types of semiconductor detectors has increased within the past two years, impelled, in part, by the great interest in the photodetection field. The surface contoured-deep junction diffusion approach was concentrated on while other investigators generally have pursued the use of a planar-oxide passivated-shallow diffused structures. Reported are results of studies of deep (25–50 microns) diffused n + p type germanium avalanche detector structures. A relatively simple closed box type process has been developed for diffusion of arsenic and antimony into germanium. Results of detector characteristics and multiplication measurements are presented. A concept for arrays of avalanche detectors (particularly to this time of silicon) is discussed. Results, in terms of uniformity of avalanche breakdown and gain, of a number of arrays fabricated are indicated together with the insight that this work has given to what appears to be the limitation of avalanche devices—resistivity inhomogeneities in the starting semiconductor crystal. These inhomogeneities take the form, at least in crystal produced by the floating zone technique, of micro-striations. An example of a developed array is shown. It is a large area quadrature instrument that, it is hoped, will find use in detection of plutonium in wounds by detecting its 17-keV x ray emanation. (auth)

40390 ON THE CdTe DETECTORS. Arkad'eva, E. N.; Maslova, L. V.; Matveev, O. A.; Ryvkin, S. M.; Rud, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 258-9(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The possibility of fabricating thick CdTe detectors with high-energy resolution is discussed. Some data on CdTe surface-barrier detectors with energy resolution ~4% for ^{57}Co gamma radiation are presented. (B.G.D.)

40391 CHARGE TRANSPORT IN SEMICONDUCTOR DETECTORS WITH TRAPPING AND DETRAPPING. Zanio, K. R.; Akutagawa, W. M. (Hughes Research Labs., Malibu, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 260-5(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The transient response of surface barrier detectors fabricated from semi-insulating CdTe has been analyzed under the conditions of trapping and detrapping. An analysis of the response of these devices to alphas allows measurement of material parameters pertinent to gamma detection and also verifies a theoretical model of trapping and detrapping. Actual and theoretical pulses presented here have a fast rising component followed by a slow rising component, the latter being associated with the release of carriers from traps. Decreasing the electric field increases the rise time and relative amplitude of the slow rising component. However, under high field conditions when detrapping times are much larger than the transit times and comparable to or greater than the trapping times, the rise time of the slow component of the pulse is nearly independent of electric field and is proportional to exp ϵ_A/kT where ϵ_A is the depth of the trap. In addition, when the detrapping time is much larger than the transit time, decreasing the temperature increases the rise time of the slow component but does not change its relative amplitude. This analysis shows that although 100% collection efficiencies may be attained in conventional solid state detectors at elevated temperatures this may not be the case at reduced temperature. Degradation in the performance of germanium spectrometers below 20°K may be explained by the trapping and detrapping of carriers. (auth)

40392 WINDOW THICKNESS AND RECTIFYING PROCESS IN SURFACE BARRIER DETECTORS. Forcinal, G.; Siffert, P.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 275-80(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The thickness of the entrance window of surface-barrier detectors is experimentally studied by determining the pulse height defect obtained from a comparison of the pulse heights measured for protons and for γ rays of 80 keV. The used detectors have resistivities ranging from 150 to 50,000 Ω-cm. It is shown that for low resistivity materials ($\rho \leq 1000$ Ω-cm) the window is formed by the gold layer only. At higher resistivities, the existence of an additional silicon dead layer is demonstrated; the thickness of this region varies in terms of the resistivity ρ and the applied bias voltage V following a function of the form A $\ln(B\rho/V)$, where A and B are constants. The experimental results are interpreted by taking into account the role of oxygen in the formation of the rectifying contact. Two possible mechanisms are discussed; in the first, oxygen is assumed to diffuse within the silicon crystal, where it acts as an acceptor; in the second, oxygen is supposed to remain adsorbed at the surface and to form an inversion layer. The first mechanism is shown to lead to the best description of the present experimental data, but the validity of the second cannot be considered as abeolutely disproved. (auth)

40393 NEW RESULTS ON THE GOLD–SILICON SURFACE BARRIER. Goradia, C. P.; Reynolds, J. (Univ. of Oklahoma, Norman). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 281-9(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The effects of certain new combinations of etch quenchants and surface treatments on the rectification characteristics of the gold-n-silicon surface barrier are described. Reverse currents of less than 1 $\mu A/cm^2$ at 1500 Volts bias at room temperature have been obtained with 450 ohm-cm silicon without using encapsulation or a guard ring structure and without prolonged aging. It is shown that differential capacitance measurements performed for determining the height of the surface potential barrier may be unsuccessful or inaccurate due to slow charge migration on the surface. Field effect measurements were performed and the surface potential and density of ionized fast states were obtained therefrom. A new ambient cycle was envolved in order to obtain the conductance minimum in the field effect measurements. It is shown that the best rectification characteristics are obtained not when an inversion layer is formed at the silicon surface but when a depletion layer is formed of just the right amount to make the surface conductance close to its minimum value. Surface treatments giving rise to strong inversion layers were found to consistently yield poor diodes. The correlation of the rectification characteristics to the density of fast states and to the thickness of the interfacial layer is discussed. The role of air and moisture in the formation of the diode is explained. A simple model of the surface barrier is presented which explains many of the observed effects. (auth)

40394 ONE AND TWO DIMENSIONAL POSITION SENSING SEMICONDUCTOR DETECTORS. Owen, R. B.; Awcock, M. L. (Atomic Energy Research Establishment, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 290-303(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Ratio and time difference methods of obtaining positional information from detectors employing charge division by resistive electrodes are discussed. Linear, radial, X-Y, and R-Theta detectors are described. (auth)

40395 INFLUENCE OF CARRIER CAPTURE ON RESOLUTION OF SEMICONDUCTOR RADIATION COUNTERS. Makovskii, L. L.; Strokan, N. B.; Tisnek, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 304-9(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A comparative analysis of the nature of collected charge fluctuations have been carried out for both possible mechanisms of the capture of carriers during their drift to the "electrodes" of a semiconductor counter, those mechanisms being either recombination or localization. An expression for the magnitude of fluctuations has been obtained which takes into account the distribution of capture inhomogeneities over the volume of a counter in terms of the Gauss function. (auth)

40396 CHARGE COLLECTION IN COAXIAL Ge(Li) DETECTORS. Sakai, Eiji (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 310-20(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Cylindrical double-open-end coaxial Ge(Li) detectors have been studied at 77°K using a small-area (circular) collimated beam of ^{137}Cs γ rays. The beam was aimed parallel to the detector axis and moved across a diameter. On different detectors, different trapping effects were observed; one detector gave better resolution and a greater pulse height when irradiated near the p-type core, another gave best performance when irradiated near the outer n^+-layer. The observed pulse shapes for different positions of irradiation showed general agreement with calculated pulse shapes based on an assumed r^{-1} variation of electric field across the i-region. (auth)

40397 RELAXATION PHENOMENA IN PLANAR Ge(Li) DETECTORS. Webb, P. P. (Radio Corp. of America Victor Co., Ltd., Montreal). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 320-6(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A study has been made of the changes in net impurity concentration which occur when Ge(Li) diodes are allowed to remain unbiased at or near room temperature (termed relaxation), and when subjected to reheat cycles. The changes occur too rapidly to be explained in terms of lithium diffusion at the junction edges. Capacitance measurements have been used to determine impurity concentration profiles, and γ-ray scanning techniques used to locate junction positions. It has been shown that a reheat at 400°C causes the compensated region to become slightly n-type. On the other hand, a device allowed to remain unbiased at room temperature becomes more or less uniformly p-type. In the samples studied (twelve diodes made from germanium from four different suppliers) generation rates of acceptors at 23°C varied from approximately 4×10^8 to $4 \times 10^{10}/cm^3$/hour. Since a well compensated diode has a net impurity concentration less than $10^{10}/cm^3$, this implies that in many diodes the degree of compensation changes substantially in a few hours. (auth)

40398 CHARACTERISTICS OF COAXIAL Ge(Li) DETECTORS THROUGH WARM-UP AND RE-DRIFT CYCLES. Sakai, Eiji;

Fowler, I. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 327-31(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Studies have been made of several cylindrical coaxial Ge(Li) detectors through various cycles of warming to room temperature and subsequent cleanup re-drift all in high vacuum. Conventional double-open-end detectors with an n^+-layer on the outside and a p-type core were used. Using the gamma-ray scanning technique it was observed that when not fully cleaned up (capacitance decreasing with increasing voltage) the i-layer thickness increased from the n-layer towards the p-core as voltage was increased, after a warm-up period, part of the i-layer nearest the core was lost with a reduction in efficiency (18% at 500V for one detector after an 8 hour warm-up period), and cleanup re-drift following a warm-up period restored the original characteristics but the cleanup time varied with the crystal from which the detector was made. (auth)

40399 PRECIPITATION OF LITHIUM IN GERMANIUM DURING ION DRIFT. Kegel, Gunter H. R. (Lowell Technological Inst., Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 332-6(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The precipitation of lithium in germanium has been investigated by Morin and Reiss and by Swalin and Weltzin. The theories developed by these investigators have been used to calculate the rate of lithium precipitation in a typical lithium-drifted germanium detector. It is found that precipitation occurs predominantly in the n^+-region of the detector. Precipitation in the intrinsic layer can be avoided, in general, by maintaining the lithium solubility at a high value in this layer. This will be the case if the electron concentration in the intrinsic layer is kept at a small value at all times. (auth)

40400 LITHIUM-DRIFTED GERMANIUM FOR CHARGED PARTICLE SPECTROSCOPY. Gruhn, C. R.; Kuo, T.; Maggiore, C.; Preedom, B.; Samuelson, L.; Chander, J. (Michigan State Univ., East Lansing). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 337-46(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The Michigan State University Cyclotron Laboratory has undertaken a program of developing lithium-drifted germanium for high-resolution charged particle spectroscopy. The charged particle spectroscopy has been concerned with reactions leading to protons, deuterons, and tritons in the energy range of 25 to 90 MeV. The emphasis of this program has been two-fold in that both the response of the detector and the packaging of the detector are considered. The side-entry geometry Ge(Li) detector was shown to be capable of 60 keV (fwhm) with 40-MeV protons. The major limitation in the resolution for this geometry is attributed to a non-uniform window (3–12μ) on the surface of the detector. The electrodes of a side entry detector were segmented and a single crystal $\Delta E-E$ counter telescope was achieved. The best resolution was achieved with a thin-window surface barrier Ge(Li) detector and measured to be 34 keV (fwhm) for 40 MeV protons. A thin slit was used and shown to give cleaner spectra over a limited range in excitation energy. A peak to valley ratio of 5000 : 1 was obtained using this thin slit. The proton radiation damage of Ge(Li) was studied at 40 MeV and shown to be an appreciable problem by 10^{10} protons/cm^2. (auth)

40401 GROWTH OF GERMANIUM FOR LITHIUM DRIFT DETECTORS. Adda, L. P. (Bell Telephone Labs., Inc., Allentown, Pa.); Benson, K. E.; deWit, R. C.; McKenzie, J. M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 347-51(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The germanium for lithium drift germanium detectors should have the following properties: high lithium drift rate, low reverse current during the drifting process particularly for high temperature drifting, minimal lithium precipitation during drifting, capability of fabrication into detectors exhibiting low noise reverse currents at high bias voltages and a minimum of carrier trapping. Germanium grown in a hydrogen atmosphere exhibits most of these desirable qualities. Measurements of ρ, τ, dislocation density, Hall mobility, conductivity, and IR absorption on both hydrogen grown and normally grown crystals have been made for correlation with detector properties. These measurements and the details of the hydrogen growth process are discussed. (auth)

40402 SURFACE PREPARATION TO OBTAIN GOOD I–V CHARACTERISTICS ON GERMANIUM LITHIUM DIODES. deWit, R. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.); McKenzie, J. M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 352-8(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

High voltage breakdown low current diodes have been made by the simple and reproducible process of quenching the final H_2O_2–HF etch of the diode with an aqueous salt solution. Of those salts tried $CaCl_2$ gives the best overall performance. Planar diodes 28 mm diameter and 5 mm drift depth have been made with leakage currents $< 5 \times 10^{-10}$ A for fields up to 600 V/mm. The diode surface noise on these units was less than 0.3 keV. The surface treatment also gives some surface passivation. (auth)

40403 RESPONSE OF SILICON TRANSMISSION DETECTORS TO MONOENERGETIC ELECTRONS. Chappell, S. E.; Humphreys, J. C.; Motz, J. W.; Berger, M. J.; Seltzer, S. M. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 359-62(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Silicon transmission semiconductor detectors with thicknesses of 191 and 530 μm were exposed to normally incident electrons with energies of 0.25, 0.50, 0.75, and 1.00 MeV. When the detector thickness is less than the incident electron range, the pulse-height distributions produced by the electrons in these detectors were characterized by an absorption peak and a relatively broad escape peak which was associated with transmission and reflection of electrons. Comparisons were made between the experimental pulse-height distributions and Monte Carlo results calculated for identical conditions. Good agreement was found between theory and experiment at 0.75 and 1.00 MeV; however, differences, that remain to be explained, appeared in the position of the escape peak at 0.25 and 0.50 MeV. (auth)

40404 PLASMA TIME IN SEMICONDUCTOR DETECTORS. Quaranta, A. Alberigi; Taroni, A.; Zanarini, G. (Univ. of Modena, Italy). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 373-80(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Several experimental results are given on plasma time in solid state detectors. They were obtained by various kinds of ionizing particles (α particles, deuterons and protons) incident on particular solid state detectors. These results refer to electric fields between 250 and 2500 V/cm and to temperatures of 300, 185, and 77°K. (auth)

40405 NEW CIRCUIT FOR PULSE SHAPE DISCRIMINATION. Jones, D. W. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 491-9(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A new electronic circuit has been developed for discriminating between pulses induced by neutrons and gammas in organic detectors. Both stilbene and NE 213 may be used as detectors with no change in the pulse shape discriminator circuit. The circuit is contained in an AEC module of standard dimensions and is designed to be compatible with modular counting systems. Pulse shape discrimination is obtained by comparing the light emitted during the early part of the pulse with the light emitted in the first 1 μsec interval. New electronic techniques employed in the comparison circuits make it possible to achieve an electronic dead time of less than 1.5 μsec. Two logic signals are provided to identify neutron and gamma pulses so that neutron and gamma spectroscopy may be simultaneously performed. The time at which these logic signals appear is defined by the application of a marker to the circuit. The circuit has been used over a neutron energy range of 1–15 MeV and applied to the measurement of energy spectra from neutron sources and to photoneutron spectroscopy. (auth)

40406 A LOW WALK, HIGH RESOLUTION TIMING SYSTEM FOR SILICON DETECTORS. Sherman, I. S.; Roddick, R. G.; Metz, A. J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 500-8(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Utilizing times of flight on the order of a nanosecond for heavy particle identification with silicon detectors, it is desirable to reliably distinguish time differences of approximately 100 picoseconds or less. In addition, the required timing circuitry must not substantially deteriorate amplitude resolution capability. In the system designed for this purpose the detector charge is first col-

lected on the capacitance of the detector and fast, low noise, preamplifier and is later transferred to the charge sensitive preamplifier. The fast signal is processed to obtain good time resolution and low walk. The system has a fwhm time resolution of 40 picoseconds, referred to 5.8 MeV deposited in a 100 pF silicon detector. An actual peak width from 3 MeV deposited in an 80 pF silicon by ^{3}He particles was 165 psec fwhm, which is about twice that expected if more optimum pulse shaping had been employed. The instrumental walk for a 100 to 1 amplitude range is less than 150 picoseconds, and is approximately 100 picoseconds for a 30 to 1 range. The noise added to the slow system is equal to that caused by an additional 17 pF of capacitance at its input, plus an overall increase of 5% or less for commonly used slow pulse shaping. (auth)

40407 LEADING EDGE TIMING CIRCUIT FOR Ge–Li DETECTORS. Waugh, John B. S. (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 509-17(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A circuit for producing a timing signal from the leading edge of slow rising Ge–Li detector output signals is described. In order to preserve the system resolution, the input signal is taken from the output of the charge sensitive preamplifier. An internal discriminator strobes the tunnel diode pick-off to reduce the noise triggering rate. The effects of multiple low-pass time constants on the walk is analyzed and found to be in agreement with the measured results. For input signals having a rise-time of 100 ns, the walk is less than 3 ns and the fwhm time jitter less than 1 ns over the range of 1 to 10 MeV. A temperature compensated delayed output circuit, adjustable over the range of 50 to 750 ns, is also included for use in conjunction with cross-over timing. (auth)

40408 A DIRECTIONAL, LOW ENERGY ELECTRON DETECTOR EMPLOYING CHANNEL ELECTRON MULTIPLIERS. Sharber, J. R.; Winningham, J. D.; Sheldon, W. R. (Southwest Center for Advanced Studies, Dallas). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 536-40(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A directional, low energy electron detector has been developed for flight aboard the Modular Auroral Probe sounding rocket. Low energy electrons incident in an aperture with a half-angle of 5° are observed at pitch angles of 50° and 130°. At each pitch angle the electron flux is measured as a function of electron energy in the range 1–16 keV. This energy discrimination is accomplished by sweeping the voltage of an electromagnet through values which focus the electrons at 160° into channel electron multipliers. In order to calibrate the instrument, an extensive experimental investigation of the fundamental properties of the recently developed channel electron multiplier was made. The results of this investigation include values of electron detection efficiency as a function of (1) incident electron energy, (2) pumping time after vacuum conditions have been reached, and (3) orientation of the electron beam on the multiplier aperture. Effects such as variation of count rate and gain as a function of high voltage applied to the multiplier are discussed. Also presented are proton detection efficiencies as a function of incident proton energy in the range 0.1–3.5 keV. (auth)

40409 SOFT X-RAY PHOTON DETECTION AND IMAGE DISSECTION USING CHANNEL MULTIPLIERS. Smith, D. G. (University Coll. of North Wales, Bangor); Pounds, K. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 541-50(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The use of channel multipliers for the photoelectric detection of x radiation in the wavelength range 2.1–67 Å has been investigated. Measurements of photon detection efficiency are presented for a bare channel multiplier and for multipliers specially coated with photoemissive materials. The variation of photon detection efficiency with angle of incidence is shown to be in fair agreement with that predicted by an analysis of the X-ray photoelectric response of a cylindrical photo-cathode. The surface yields derived from the measurements for LiF and MgF_2 are compared with other published data, based on plane photocathode measurements, and shown to be in good agreement. A specific application of the channel multiplier in x-ray astronomy is described. The results of an investigation into the x-ray response and spatial resolution of a channel multiplier array are also presented. The measured resolution is close to the expected value. The application of arrays of channel multipliers to image dissection in x-ray spectroscopy is discussed. (auth)

40410 SOFT X-RAY IMAGING SYSTEM FOR SATELLITE EXPERIMENTS. Ballas, J.; Knapp, G.; Wiza, J.; Zehnpfennig, T. (American Science and Engineering, Inc., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 551-55(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

An imaging system for locating sources of soft x-ray emission in the 3-12 Å spectral range has been developed. Although specifically designed to provide a visual display of solar flare activity to human observers in an orbiting solar observatory, simple modifications would make it compatible with the data acquisition and transmission subsystems of unmanned satellites. The imaging optic consists of a grazing incidence mirror having a collecting area of 2.3 cm^2. An x-ray image is formed on an 0.005″ thick CaF_2 (Eu) crystal in intimate contact with the fiber optic faceplate of an image dissector tube. Single photoelectrons are detected. Spatial information is obtained by correlating count rate with the voltages applied to the image dissector deflection plates. (auth)

40411 A SOLID STATE DETECTOR EXPERIMENT FOR ELECTRON MEASUREMENTS ON OGO–F. Trainor, James H.; Williams, Donald J. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 562-5(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A solid-state detector system is described which has been developed for flight on an Orbiting Geophysical Observatory in polar orbit. Measurements will be made of the electron flux and spectra above 35 keV, both for precipitating and locally mirroring electrons, as well as atmospheric backscatter. The physical need and the design requirements of such an experiment are reviewed and the detector and electronic implementation of the experiment including the methods of monitoring detector and electronic performance in flight are described. (auth)

40412 A METHOD OF MEASURING THE COSMIC RAY CHARGE COMPOSITION BETWEEN 10^{10} AND 10^{14} eV. Ormes, J. F.; Balasubrahmanyan, V. K.; McDonald, F. B.; Price, R. D. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 566-71 (June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The details of an experiment to measure the charge composition of the primary cosmic radiation from Z = 1 to about 50 in the energy range 10^{10} to 10^{14} eV are reported. A large geometry factor of ~7500 cm^{2}ster is necessary to measure intensities at the low flux levels of these particles. The necessary charge resolution can be obtained using ½ m × ½ m square detection elements in the following manner. The linearity properties of CsI scintillators and Cerenkov detectors make them ideal for primary charge identification. Further change information and a fast coincidence pulse will be obtained from two geometry defining plastic scintillators. The fast coincidence pulse will trigger a digitized spark chamber which will provide sufficient directional and positional information so that resolution comparable with much smaller area detectors can be obtained. The energy of the incident particles is determined using total energy spectrometers. The module for examining electromagnetic cascades consists of six tungsten-scintillator elements each of one cascade length thickness and each pulse height analyzed. The energy of incident nucleons is measured in the 20 elements of an iron-scintillator ionization calorimeter. It has a total depth of 3.5 nuclear interaction mean free paths. (auth)

40413 RARE EARTH PHOSPHORS AND SCINTILLATORS. Buchanan, R. A.; Wickersheim, K. A. (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 95-101(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Luminescent rare earth compounds are receiving renewed attention as a result of their successful application as phosphors for color television and lighting and as crystals for solid state lasers. The compounds of practical interest are hardy materials, frequently simple or complex oxides in which the rare earth activator occurs in the trivalent state. The results of a partially completed survey of electron- and x-ray-stimulated luminescence of the rare earths in selected oxide hosts, on the basis of which it is possible to draw preliminary conclusions regarding the suitability of such materials for scintillation and other radiation detection and measurement applications are presented. The luminescent compounds fall into two categories. Materials of the first category exhibit the sharp line spectra characteristic of transitions within the 4f electron shell. Efficiencies of materials in this category are high but

decay times range from microseconds to milliseconds. As a result, their greatest utility would seem to lie in imaging and energy conversion applications. Materials of the second category exhibit broad-band spectra. These spectra arise from either 5d to 4f transitions of the activator ions or from emission of the host itself. Decay times fall in the range from tens of nanoseconds to microseconds. Consequently, these materials have the greatest potential for scintillation counting application. The best materials from each of the classes are discussed. (auth)

40414 NEW LIQUID SCINTILLATORS WITH HIGHER SPEED AND EFFICIENCY. Lynch, Frank J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 102-6(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The variation of light intensity with time following excitation by gamma rays has been measured for toluene solutions of quaterphenyl, quinquiphenyl, and sexiphenyl compounds whose solubilities were enhanced by substitution of alkyl groups. The decay curves, measured by use of a light-intensity-sampling technique, were analyzed to yield the mean lives τ_1 for energy transfer from solvent to solute, τ_2 for decay of the fast component (from the singlet state), and τ_3 for decay of the slower component (probably from excimers). Preliminary estimates of τ_2 for quaterphenyl, quinquiphenyl, and sexiphenyl are 1.27, 1.22, and 1.02 nsec, respectively. As expected, τ_1 appears to vary inversely with solute concentration, and at the highest concentration of quaterphenyl in toluene (~65 g/liter, $\gamma = 1.12 \times 10^{-2}$) was < 0.1 nsec. At this concentration, the amount of light in the slower component was only about 1/6 of the total light. This indicates that formation of excimers is inhibited. In addition, the photoelectrons produced in an RCA-8575 photomultiplier per keV of energy lost in the scintillator was measured to be 2.1 for quaterphenyl, 2.2 for quinquiphenyl, and 1.9 for sexiphenyl solutions. The improvement in efficiency and speed is reflected in a corresponding improvement in the time resolution achievable with these scintillators. For a 300-keV energy loss in the quarterphenyl solution, the FWHM was 0.20 nsec and the effective T_s was 0.035 nsec. (auth)

40415 TIME DEPENDENCE OF SCINTILLATIONS AND THE EFFECT ON PULSE-SHAPE DISCRIMINATION. Kuchnir, Franca T.; Lynch, Frank J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 107-13(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The time dependence of the light following excitation by gamma rays and neutrons was measured for stilbene and for the liquids NE-213, NE-213M, and NE-218. In addition, the number of photoelectrons produced at the cathode of an RCA-8575 photomultiplier per keV energy loss in the scintillator has been determined for each of these scintillators. A straightforward technique for pulse-shape discrimination is described; it consists in measuring the time difference between the start and the instant at which the integrated photomultiplier pulse reaches a specified fraction of its final amplitude. From the measured scintillation decay, the probability distribution of these rise times has been calculated for different fractions and for different photon and neutron energies on the assumption of Poisson statistics. These calculated distributions are in agreement with the experimental results obtained with the above-mentioned technique. The pulse-shape discriminating system is very stable and will accept 80% of the neutrons at 350 keV and only approximately 1% of the gamma rays producing scintillations with equal integrated light. (auth)

40416 TEMPERATURE DEPENDENCE OF ENERGY DEGRADATION IN ORGANIC LIQUID SCINTILLATORS. Levin, Eugene M. (City Univ., New York); Furst, Milton; Kallman, Hartmut. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 114-16(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Under high energy excitation, organic molecules are generally excited to electronic states above the first excited state. Since, at not too high solute concentrations, energy transfer in organic liquid scintillators occurs via the first excited electronic state, the efficiency of degradation to this state affects the overall light output. Experimental results for a number of systems, at temperatures from 20 to 240°C are reported. It was found that the efficiency of degradation to the first excited state generally decreases with increasing temperature, with some variation among the solvents tested. It was found that the greater the efficiency of degradation to the first excited state at 20°C, the less this efficiency varies with temperature. (auth)

40417 EMISSION AND DECAY OF EXCITED ORGANIC MOLECULES UNDER ELECTRON IMPACT. Abu-Zeid, M. E. M.; Christophorou, L. G.; Carter, J. G.; Birkhoff, R. D.; Harter, J. A. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 117-21(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The emission and decay of a number of benzene derivatives in the liquid phase, excited by electron impact, are characteristic of singlet state excimers. (auth)

40418 ANISOTROPY OF SCINTILLATION RESPONSE OF ANTHRACENE TO NEUTRON GENERATED RECOIL PROTONS AND CARBON IONS. Oliver, D. B.; Knoll, G. F. (Univ. of Michigan, Ann Arbor). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 122-6(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The directional anisotropy in the scintillation response of an anthracene crystal to heavy charged particles was investigated. Energetic carbon and hydrogen ions were produced internally by scattering fast neutrons from the constituent nuclei. By use of a two detector coincidence system, the scintillations due to monoenergetic ions recoiling in a particular direction were selected and analyzed. The energies of the ions ranged from 2 to 3.5 MeV for the carbon recoils and from 0.9 to 7.3 MeV for the hydrogen recoils. Even though there was a wide variation in the average specific energy loss of the heavy charged particles considered, the magnitude of the anisotropy only varied between 39% for the carbon recoils and 20% for the 7.3 MeV hydrogen recoils. The measured hydrogen ion response in a particular direction as a function of energy was found to be approximately described by the formula suggested by Birks, $dL/dE = (1 + kBdE/dx)^{-1}$, with kB being directionally dependent. The directional carbon ion response appeared to be a linear function of energy over the energy range investigated. (auth)

40419 RESPONSE OF STILBENE TO INTERNALLY GENERATED PROTONS. Geller, K. N. (Drexel Inst. of Tech., Philadelphia); Eccleshall, D.; Bardin, T. T. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 127-35(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A thick radiator neutron spectrometer has been constructed in which protons recoiling forward in the stilbene escape from the crystal and are detected in a silicon surface barrier counter. The coincident pulses from the two counters are recorded using a two-parameter analyzer. The instrument has been used to investigate (1) the response of stilbene to protons originating within the scintillator and (2) the behavior of the pulse shape discrimination as a function of the energy deposited in the stilbene crystal. The response function, which is required for the analysis of the neutron spectra, is compared with one obtained for protons incident externally on the same crystal. Small differences between the two response functions are observed and analyzed. Concerning the behavior of the pulse shape discrimination between protons and electrons it is found that, for internally generated protons, the ability to separate protons from electrons worsens as the energy deposited in the scintillator decreases. This contrasts with the behavior for protons which stop in the scintillator. The results support the hypothesis that the fast component of the pulse decreases with increasing stopping power whereas the slow component depends primarily on the energy lost. The results are analyzed and may be interpreted with certain assumptions to give the ratio of the fast and slow scintillation components. (auth)

40420 DEVELOPMENT OF A DOUBLE LAYERED SCINTILLATOR FOR SEPARATING AND DETECTING LOW ENERGY PROTONS AND ELECTRONS. Mozer, F. S. (Univ. of California, Berkeley); Boggott, F. H.; Bates, C. W. Jr. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 144-6(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A scintillator system consisting of a thin (5,000–15,000 Å) CsI(Tl) layer evaporated onto a plastic scintillator (NE-102) has been developed for the purpose of distinguishing low energy protons from electrons and measuring the energy of each species. Evaporations in a high vacuum (10^{-5} torr) produced layers of CsI(Tl) that scintillate with an efficiency comparable to optimally doped bulk material. If the CsI(Tl) layer thickness is 15,000 Å, it stops protons with energies below 170 keV and electrons with energies below 18 keV. Thus, protons with energies between about 25 and 250 keV can be distinguished from electrons with energies above 18 keV by examining the shape of the light pulse generated

in the dual scintillator. Results obtained with protons and electron beams will be presented. (auth)

40421 DEPENDENCE OF THE NaI(Tl) PULSE SHAPE OF THALLIUM CONCENTRATION AND TEMPERATURE. Wall, W. R.; Roulston, K. I. (Univ. of Manitoba, Winnipeg, Can.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 153-7(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The pulse shape of γ-induced photopeak scintillations in NaI(Tl) has been measured as a function of temperature for several standard commercial crystals and for crystals containing known thallium concentrations. A detailed analysis of the data indicates that the first two microseconds of the pulse are characterized by at least nine separate decay processes. Four of these are attributed to one radiative and three metastable states associated with a thallous ion. Two fast processes are attributed to emission characteristic of pure NaI while two others are associated with high thallium concentration. Energy transport is suggested as the ninth process. (auth)

40422 LUMINESCENCE FROM NaI(Tl) BETWEEN 5°K AND 80°K. Kaufman, R. Gilbert; Hadley, Wayne B. (Zenith Radio Corp., Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 158-61(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The several emission bands of scintillator crystal NaI(Tl) excited by X-irradiation have been studied between 5 and 80°K. It was possible to trap electrons as Tl^0 and holes as I_2^- and Tl^{++} during irradiation and cause recombination thermally or by optical stimulation after irradiation to give the same emissions. The processes responsible for recombination after irradiation are discussed and assignments based on these results made for processes during irradiation. (auth)

40423 THE CONTRIBUTION OF THE NaI(Tl) CRYSTAL TO THE TOTAL LINEWIDTH OF NaI(Tl) SCINTILLATION COUNTERS. Narayan, G. H.; Prescott, J. R. (Univ. of Calgary, Alberta). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 162-6(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Monte-Carlo calculations have been performed to determine how much of the broadening of the output pulse of NaI(Tl) scintillation counters is due to the nonproportionality of response of NaI(Tl) to electrons, for incident photons of energy 10 keV to 1 MeV. Interactions taking place in the crystal have been simulated in detail and take into account fluctuations in light output, due not only to the primary Compton and photoelectric processes, but also to energy-loss fluctuations in the ionizing process along the track of individual electrons. The contribution of these fluctuations is important at energies above 200 keV but a substantial fraction of the experimental line broadening at low energies remains unaccounted for. It is suggested that the contribution of the crystal to the total broadening is quite sensitive to the shape of the electron response curve. (auth)

40424 SECONDARY-ELECTRON EMISSION. Simon, R. E.; Williams, B. F. (David Sarnoff Research Center, Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 167-70(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The secondary-emission process, which is fundamental to photomultipliers used in scintillation counters, can be considered to consist of three physical processes: (1) excitation of secondary electrons, (2) transport of these electrons through the solid, and (3) transport through the vacuum-solid interface. Based upon these processes, a model can be derived which explains the shape and magnitude of the secondary-emission yield curves as well as the velocity distribution of the emitted electrons. Furthermore, such a model can be useful in the search for better secondary emitters. The application of certain solid-state concepts such as band bending to the preparation and processing of appropriate semiconductors has led to enormous improvement in the transport and escape of secondary electrons and has made possible the development of a new type of secondary emitter with a maximum yield which is an order of magnitude or more greater than the yields of the best previously described materials. These secondary-electron emitters may be useful in producing multipliers with fewer stages, better statistics, and higher speeds than those presently available. (auth)

40425 NEW DEVELOPMENTS IN GAS FILLED IMAGE INTENSIFIER DETECTORS FOR X AND GAMMA RAYS. Roux, G.; Gaucher, J. C.; Leloup, J.; Morucci, J. P.; Lansiart, A. (CEN de Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 67-75(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

In spark operation, with short-circuit electronics having a triggering delay of $\leq$ 40 ns and yielding a peak current of 15 Amperes, the detector, which is filled with xenon (720Torr) and diethylamine (40 Torr) has a counting plateau equal to 4% of the mean operating voltage. The electronic short-circuit is more effective when diethylamine replaces methylal. It is shown that this vapour produces a delay in the triggering of the spark. The life is improved. Study of electron avalanches has shown that, in the case of detection of x rays of a mean energy of 27 keV, the number of carriers which they contain may reach 10^8 and that the probability is then less than 10^{-4} for triggering sparks. These avalanches also make it possible to obtain completely proportional amplitude spectra of excellent resolution (9% for 27 keV). When the detector is used in avalanche operation, the light emitted by the latter enables an image of the x ray emitting source to be recorded. The quantity of light emitted can be increased by increasing the number of carriers in the avalanche but at the risk of creating a spark. This risk is eliminated by a short-circuit system similar to that operating for spark conditions but with a triggering threshold corresponding to about 10^5 electrons. The possibility of using this detector for recording X-ray diffraction patterns on biological molecules is discussed. (auth)

40426 LEAD FLUORIDE CERENKOV SHOWER COUNTER. Dally, E. B.; Hofstadter, R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 76-9(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The resolution of lead fluoride crystal was measured with electrons or positrons at 100 MeV to 14 GeV. Measurements from 100 MeV to 1 GeV have been performed at the Mark III High Energy Physics Laboratory electron linear accelerator at Stanford using a parasite positron beam. The tests between 2 to 14 GeV were made with electrons at the Stanford Linear Accelerator Center using the C-beam parasite facility. It is assumed that the response is nearly identical for positrons electrons, and gamma rays. (B.G.D.)

40427 GAS PROPORTIONAL SCINTILLATION COUNTER WITH XENON AND XENON MIXTURES. Conde, C. A. N.; Policarpo, A. J. P. L.; Alves, M. A. F. (Univ., Coimbra). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 84-91(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The light output of the recently developed gas proportional scintillation counter, a gas scintillation counter with light multiplication produced by a cylindrical geometry electric field, is investigated for heavy gaseous media under alpha particle excitation with a 56 UVP phototube. The gases used are Xe, and Xe–Ar and Xe–N_2 mixtures for a wide range of concentrations, at a total pressure of about 965 torr. The light output of the Xe–Ar mixtures shifts towards the ultraviolet ($\lambda \lesssim 3250$ Å) region as the electric field intensity increases. Xe–Ar mixtures with Xe concentrations ranging from about 1 to 10% give, with a p-quaterphenyl wavelength shifter, a light output more than two orders of magnitude larger than that of a CsI(Tl) scintillator. In Xe–N_2 mixtures with wavelength shifter nitrogen has a quenching effect. For the mixtures of noble gases the rise time of the secondary component of the light pulse is slow, typically 15 μs. Methane and nitrogen while having a quenching effect, reduce this rise time. (auth)

40428 USE OF SEMICONDUCTORS DOPED WITH ISOELECTRONIC TRAPS IN SCINTILLATION COUNTING. Madden, T. C.; Merz, J. L.; Miller, G. L.; Thomas, D. G. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 47-57(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The use of semiconductors as scintillation phosphors is discussed. Donor-acceptor pair recombination is efficient but it is often slow. The presence of free carriers from high concentrations of electrically active defects causes concentration quenching probably by means of an Auger effect. One is led therefore to consider the use of semiconductors doped with isoelectronic traps. Experiments are reported for CdS doped with tellurium and ZnTe doped with oxygen. Promising preliminary results have been obtained. For CdS:Te at room temperature using 5-MeV α particles pulse heights have been recorded 7 times greater than those pro-

vided by the scintillator Pilot B, and with a rise time of 300 ns. At 100°K the results are even better. An excellent linearity of response at 100°K was found for particles with energies between 7 keV and 5.2 MeV. In addition to detecting α, β, and γ particles, CdS : Te is also a good potential detector of thermal neutrons. (auth)

40429 ELEVENTH SCINTILLATION AND SEMICONDUCTOR COUNTER SYMPOSIUM, WASHINGTON, D. C., FEBRUARY 28–MARCH 1, 1968. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., 15: 1-600(June 1968). (CONF-680207).

Separate abstracts were prepared for 75 of the 78 papers presented. Three papers were previously included in NSA. For abstract numbers of these papers see CONF 680207 in a cumulative report number index. (B.G.D.)

For abstracts of individual papers see: 40385–40428, 40430, 40440–40453, 40455, 40463–40467, 40496–40504, and 40512.

40430 RECENT ADVANCES IN X-RAY DETECTION TECHNOLOGY. Aitken, D. W. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 10-46 (June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A review is presented of recent developments in x-ray photon detectors and in the associated detector electronics. A survey of the presently available physical information on the intrinsic resolution of silicon and germanium radiation detectors, proportional counters, and NaI(Tl) scintillation crystals is presented. Semiconductor detectors suitable for x-ray applications and low noise electronics are then analyzed in some detail. Discussions follow on scintillation detectors, proportional counters, and external photoelectric detectors. Recent spectral achievements and interesting applications are illustrated. 137 references are included. (auth)

40431 CHINO USES RADIATION LOGGING FOR STUDYING DUMP LEACHING PROCESSES. Howard, E. V. (Kennecott Copper Corp., Santa Rita, N. Mex.). Mining Eng., 20: 70-4(Apr. 1968).

A radiation logging technique was developed to aid in locating leach solutions, and to measure the density, porosity, degree of saturation, and moisture content of leach dumps. It provided a reliable method for locating leach solutions within the dump; the contact between the leach solutions and the copper-bearing material determined recovery. Three techniques were used: γ-ray logging; neutron-neutron, or moisture logging; and γ-γ, or bulk density logging. The natural γ method uses a scintillation detector with transistorized signal amplifier and high voltage power source. The neutron-neutron method uses a ^{3}He neutron detector with transistorized signal amplifier, high voltage power source, and a 3-Ci ^{241}Am–Be neutron source. The γ-γ method employs a scintillator detector with transistorized signal amplifier, high voltage power source, and a 125-mCi ^{137}Cs γ-ray source. Physical bases of the logging techniques are explained. Operation consisted of preliminary calibration, lowering the down-hole tool into the drillhole and recording determinations as a function of depth. Logging in the drillholes provided much information on the process of leaching. (BBB)

40432 CERTAIN LUMINOSITY CHARACTERISTICS OF IONIZATION CALORIMETER INSTALLED IN PROTON SATELLITE. Kovrizhnykh, O. M.; Mishchenko, L. G. (Scientific-Research Inst. of Nuclear Physics, Moscow). Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 5, 72-9(Sept.-Oct. 1967). (In Russian).

A method for measuring luminosity from plastic scintillators used as detectors in the ionization colorimeters and a procedure for equalizing the light gathering ability of the photo multipliers are outlined. (tr-auth)

40433 NUCLEAR MEDICAL LOCALIZATION DIAGNOSTICS. Wolf, Rudolf (Univ., Mainz). Med.-Markt/Acta Medicotech., 15: 407-11(Oct. 1967). (In German).

Some theoretical and practical aspects of the use of radioisotopes for localization and diagnosis in humans are reviewed. Types of instrumentation, including rectilinear scanners, positron detection equipment and procedures, the gamma camera, multiple head scanners, the autofluoroscope, spark chamber detector, and the methods and procedures associated with their use, are discussed. Methods for improved presentation and interpretation of scintigrams are reviewed and discussed. (BBB)

40434 USE OF FISSION FRAGMENT MICA AND GLASS DETECTORS FOR RECORDING NEUTRON BEAMS. Kashukeev, N. T.; Neova, I. D.; Ribarov, S. R. (Bulgarian Academy of Science, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 107-10(1968). (In Russian).

An attempt was made to show that mica and glass detectors can be used for recording neutron beams. Moreover, the recording may be accomplished visually, without the aid of a microscope. Plain 9 × 12 cm photographic plates and 50 to 100 micron thick mica plates made of natural muscovite with targets made of 90% ^{235}U were used in the experiments. Images of neutron beams in 10% HF acid with neutron flux 2×10^{7} n/cm² sec 5, 10, and 30 min exposition are shown. The suggested method proved successful and efficient due to the absence of background induced by γ rays and light charged particles; the irradiation and treatment of detector specimen, are carried out with light. Glass detectors proved more efficient. (R.V.J.)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 40013.

40435 (ANU-P-399) USE OF A DOUBLE-FOCUSSING SPECTROMETER FOR NUCLEAR REACTIONS AT 180°. Elliott, R. V. (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1968]. 6p. Dep.

The system described provides a method for using a double-focusing spectrometer to observe reactions at 180° to the beam direction. To account for changes in K, the spectrometer is rotated about the incoming beam direction on an axis parallel to the z-axis. Calculations of the beam trajectories indicate that the method is feasible. The system has the advantages that the area around the target chamber is unencumbered by an auxiliary magnet and that the spectrometer aperture is at 180° to the beam direction for all values of K. Also the system proposed requires a relatively small auxiliary magnet compared with other systems. (auth)

40436 (BNL-12622) PULCAL: A COMPUTER PROGRAM TO OBTAIN PEAK ENERGIES FROM CHANNEL NUMBERS WHEN A PRECISION PULSER HAS BEEN EMPLOYED TO CORRECT FOR NONLINEARITY. Mariscotti, M. A. J. (Brookhaven National Lab., Upton, N. Y.). June 20, 1968. 13p. Dep. CFSTI.

A computer program is described which finds the number of pulser peaks, finds the number of gamma-ray peaks, finds the pulser peaks flanking each gamma ray peak, computes the position of gamma-ray peaks and pulser peaks, and then computes the energies of the gamma-ray peaks. (W.H.K.)

40437 (EUR-CEA-FC-255) UN ANALYSEUR ELECTROSTATIQUE POUR LA DETECTION DES NEUTRES RAPIDES. (Electrostatic Analyzer for Detection of Fast Neutrals). Valckx, F. P. G. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1964. 16p. (In French). Dep.

An electrostatic analyzer designed for the measurement of the energy spectrum of fast neutral particles was described. An electrostatic deflector at 90° analyzes the energy of the particles previously ionized in a gas target. The maximum energy is 200 keV. The resolution capacity is variable from 0.05 to 2.5%. (tr-auth)

40438 (INR-P-898/II/PS) SPECTROMETER FOR INELASTIC SCATTERING OF THERMAL NEUTRONS STUDIES AT THE PULSED IBR REACTOR. Sosnowski, Jerzy; Sosnowska, Izabela; Maliszewski, Edward (Institute of Nuclear Research, Warsaw (Poland)). 1968. 19p. (CONF-680501-5). Dep.

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark.

The design of a spectrometer for studies of inelastic coherent scattering of thermal neutrons by single crystals at the IBR reactor is described. A polychromatic pulse neutron beam is scattered by a single crystal sample and the energy of scattered neutrons is analyzed by three analyzing single crystals for three different beams of scattered neutrons. The time-of-flight technique is used to measure the incident neutron energy. The spectrometer is adapted for simultaneous structure and lattice dynamics studies of solids. Special features of this spectrometer and its applications are discussed. (auth)

40439 APPARATUS FOR AUTOMATIC STANDARDIZATION WITH EXTERNAL STANDARDS IN LIQUID SCINTILLATION SPECTROMETRY. Packard, Lyle E. (to Packard Instrument Co., Inc.). U. S. Patent 3,390,269. June 25, 1968. Filed June 18, 1964.

The design of a liquid scintillation spectrometer system for analyzing beta-emitting radioactive samples is presented. The system is calibrated by exposure to standardized external radiation. (W.H.K.)

40440 ULTRA STABLE REFERENCE PULSER FOR HIGH RESOLUTION SPECTROMETERS. Strauss, M. G.; Sifter, L. L.;

Lenkszus, F. R.; Brenner, R. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 518-30(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A solid state, double pulse generator with a pulse amplitude temperature coefficient of 0 to −8 ppm/°C was developed. It is shown that when a servo-stabilized spectrometer is locked on the pulser peaks, the gain and zero-intercept of the system drift only ±20 ppm/day or less than $^1/_{10}$ of the optimum resolution of Ge(Li) detectors. The pulser generates signals which rise in 15 nsec, remain flat-topped for 40 μsec and then fall exponentially to the baseline in 250 μsec. The pulse rate can be varied from 0.1−1000 pulse-pairs/sec in 9 steps. The amplitude of the two pulses can be set independently from 5.5−700 mV, using a 7-bit precision R-2R attenuator. When used in conjunction with a preamplifier test capacitor of 1 pF, this amplitude range corresponds to 0.1−12.7 MeV (Ge). A tag pulse, generated in coincidence with each reference pulse, can be used for gating a multichannel analyzer, a coincidence system or a stabilizer. The performance of the pulser was measured with a computer based, servo-stabilized multichannel analyzer in which the two ^{60}Co lines from a Ge(Li) detector were used as the stabilizer reference peaks. The pulser signal was injected into the preamplifier via a 1 pF air-dielectric capacitor mounted in a temperature regulated oven. The pulser peak was set between the ^{60}Co peaks, and its location was measured as a function of temperature, supply voltage and repetition rate. For each measurement the computer calculated and tabulated the centroid, the standard deviation of the centroid and the fwhm of each of the three peaks. The shift of the pulser peak relative to the ^{60}Co peaks is a measure of the pulser stability. (auth)

40441 A TOTAL ABSORPTION Ge(Li) GAMMA RAY SPECTROMETER. Kraner, H. W.; Chase, R. L. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 381-92(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A configuration of a large Ge(Li) detector has been developed which suppresses single, local interactions, particularly Compton scatterings. The peripheral n^+ contact of a coaxial detector is split into two or more segments, and events are recorded from the central p contact if signals are coincidentally present on two segments of the n^+ contact. A sum signal is derived from the central p contact through a high resolution preamplifier, and individual localization signals are taken from each segment of the n^+ contact through simple voltage-sensitive preamplifiers. The maximum sensitivity of the system lies between 300 and 1300 keV where the Compton cross-section is dominant and many Compton scattered γ-rays are not sufficiently energetic to escape. The total absorption mode achieves about 20% of the photopeak efficiency of the detector operated in the normal singles mode. An increase in the ratio of the full energy peaks to the Compton continuum of 10 : 1 is found for ^{60}Co γ-rays, and it is significantly greater for γ-rays of less than 1 MeV. The use of internal detector summing of the linear signal eliminates the need for complicated external preamplifier gain adjustment and stability. Capacitively coupled, voltage-sensitive preamps on each n^+ segment add negligible noise and reduce the sum signal-to-noise ratio only to the extent that the input shunt capacitance used reduces the sum signal level by about 10%. Thus, a 30 cc split n^+ detector yields 3.9 keV ^{60}Co resolution in the coincidence mode compared with 3.5 keV when both n^+ segments are grounded. (auth)

40442 ALL GERMANIUM ANTI-COMPTON SPECTROMETER. Sayres, A. R.; Baicker, J. A. (Princeton Gamma-Tech, Inc., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 393-6(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A two crystal Ge(Li) detector system has been developed for use as an anti-Compton gamma-ray spectrometer. The basic components of this system are a pair of Ge(Li) detectors mounted in tandem. Coincidence techniques are used to require a gamma ray to interact by multiple processes (e.g., one or more Compton events followed by a photoelectric event) in each portion of the pair of detectors. The total energy deposited is then recorded. Energy absorbed by a single process (e.g., one Compton event) is not recorded. The resulting spectrum is made up of full energy peaks above a low and featureless background characterized by the absence of Compton edges. An investigation of the efficiency and peak-to-background ratio as a function of gamma ray energy has been made for this new gamma-ray spectrometer. (auth)

40443 A Ge(Li) CONCENTRIC DUODE SPECTROMETER FOR COMPTON SUPPRESSION. Palms, J. M.; Wood, R. E.; Puckett, O. H. (Emory Univ., Atlanta). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 397-406(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A Ge(Li) Compton sum coincidence spectrometer which greatly reduces the Compton continuum and essentially eliminates the Compton edges for low energy gammas has been fabricated. This spectrometer was made from a single cylinder of germanium in which lithium was drifted to form two separate and equal depth concentric detectors. An event in the full energy peak is recorded only if the total energy deposition occurs as the result of multiple events, with each detector sharing in the absorption process. Several types of gamma-ray spectra are presented which show the reduction of the Compton continuum. For the case of the 1275 keV gamma from ^{22}Na the ratio of the full energy peak to Compton edge (in this case a multiple Compton event edge) increases from 2.8 to 1, when the device is used as the sum of two single spectrometers, to 13.5 to 1 when it is used in the sum coincidence mode with a decrease of efficiency of a factor of five. This ratio for the 511 keV line from ^{22}Na increases from 3.6 to 1, to 18 to 1. Other spectra are shown and a discussion of efficiency is presented. (auth)

40444 AN ANTICOINCIDENCE-SHIELDED Ge(Li) GAMMA-RAY SPECTROMETER FOR HIGH SENSITIVITY COUNTING. Cooper, J. A.; Wogman, N. A.; Perkins, R. W. (Battelle-Northwest, Richland, Wash.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 407-12(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

An anticoincidence-shielded Ge(Li) gamma-ray spectrometer for high sensitivity counting is described. The system consists of a 20 cc coaxial diode centered inside a 26″ diameter by 24″ thick plastic phosphor. The source is placed inside the shield and both the coincidence and anticoincidence spectra are recorded simultaneously. The anti-coincidence shield reduces the ^{137}Cs Compton edge by a factor of 7.5 to provide a peak to Compton edge ratio of 150 : 1 without reducing the photopeak efficiency by more than 3%. This system also provides a two to fourfold lower natural radionuclide background than similar sized diodes.

40445 COINCIDENCE EXPERIMENTS WITH COAXIAL Ge (Li) DETECTORS IN THE LOW ENERGY RANGE. Ostertag, E.; Miehe, J. A.; Henck, R.; Siffert, P. (CEN, Strasbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 413-18(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A γ−γ coincidence arrangement employing two large volumes (20 cm^3) Ge(Li) coaxial detectors has been realized. Each diode has two isolated outputs, one of which yields the energy information of the incident radiation and the other one the timing signal. The prompt resolution curve obtained with a ^{60}Co source has a full width at half maximum of 11 ns. Coincidence γ-ray spectra are observed with one Ge(Li) detector when the other is gated on the 1333 keV full energy peak. The use of a 30 ns coincidence resolving time results in an undistorted coincidence spectrum for energies higher than about 150 keV. In order to illustrate the applications of this technique, results obtained in γ−γ coincidence experiments with the complex γ-ray emitter ^{133}I are presented and discussed. (auth)

40446 A 12-CHANNEL SEMICONDUCTOR COUNTER SYSTEM FOR THE NBS ELECTRON SCATTERING SPECTROMETER. Lightbody, J. W. Jr.; Penner, S. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 419-25(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A 12-channel array of lithium-drifted silicon detectors for detecting high energy electrons in the focal plane of a magnetic spectrometer is described. The detectors are movable along the focal plane and are backed up by two large stationary plastic scintillators. The scintillators are placed one behind the other, such that a count is recorded when a triple coincidence occurs between both scintillators and a single semiconductor detector. The system has a momentum resolution of 0.036 percent, determined by the detector size and the spectrometer momentum dispersion. Discriminator curves have been obtained which show sufficiently flat plateaus to afford stable counting conditions for electron momentum greater than 20 MeV/C. Detector efficiency measurements have also been made which show that the relative efficiencies of the detectors are stable and known to less than two percent of their values. An electron scattering experiment is now in progress using these detectors. (auth)

40447 SPECTROMETER FOR ENERGETIC NEUTRONS. Madey, Richard (Clarkson Coll. of Tech., Potsdam, N. Y.).

IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 426-36(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A time-of-flight spectrometer has been designed to detect neutrons in the energy region from 10 to 100 MeV (and possibly also to higher energies). The principle of the spectrometer requires an incident neutron to lose a small fraction of its energy in a collision with a proton in a scintillator. The scattered neutron must then travel over a suitable flight path before interacting in a second scintillator. The time interval between the two scintillation pulses is a measure of the neutron energy. The small energy-transfer condition on the scattering process is imposed by restricting the kinetic energy of the recoil proton to be less than a predetermined value. Means for discriminating against background events include an anticoincidence detector for rejecting charged particles and a pulse-shape discrimination scheme for rejecting neutron interactions with carbon nuclei. Gamma-rays are rejected by time-of-flight and also by the pulse-shape discrimination circuitry. The spectrometer may be designed either for low counting rate applications such as measurements of fluxes and spectra of the energetic-neutron component of stray radiation fields around particle accelerators, or for higher counting rate experiments such as angular and energy distribution measurements of energetic-neutrons produced in the bombardment of both thin and thick targets. For the case of 14 MeV neutrons emerging isotropically from a target, a typical detector configuration consists of a first scintillator with a volume of 103 cc, a second cylindrical scintillator with a diameter of 10 cm, and a mean spacing between the two scintillators of 1.91 meters. At a distance of 50 cm from an isotropic source of 10^7 neutrons per second, the first scintillator will respond to neutron-proton interactions at a rate of about 1000 per second, whereas the spectrometer counting rate of 14 MeV neutrons is expected to be about 7 per minute. (auth)

40448 GASPAN: AN ADVANCED COMPUTER CODEN FOR THE ANALYSIS OF HIGH RESOLUTION GAMMA-RAY SPECTRA. Barnes, V. (United Kingdom Atomic Energy Authority, Seascale, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 437-54(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The underlying principles of a computer code to automatically analyze a gamma-ray spectrum obtained with a Ge(Li) detector are described. The significant peaks present in the spectrum are detected by observing changes in the first derivative which is measured after random variations in count-rate have been minimized by the application of a smoothing function. Pseudo-peaks due to backscattering events or Compton edge effects are eliminated, and the intensities and energies of the component gamma-rays are calculated by fitting a Gaussian function to each peak in turn. The analysis of overlapping peaks is considered and conditions chosen to optimise their detection. It is shown that if a catalog of gamma-ray energies is available to the computer then it is possible to automatically identify the component isotopes and evaluate their activities. (auth)

40449 OPTIMUM SIGNAL-PROCESSING FOR PULSE-AMPLITUDE SPECTROMETRY IN THE PRESENCE OF HIGH-RATE EFFECTS AND NOISE. Radeka, V. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 455-70(June 1968). (BNL-12325).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The idea of a general signal processing system which should satisfy various pulse rate and noise requirements is explored. Optimum processing functions (weighting functions) are considered for an ideal system, and for real conditions where effects like imperfect pole-zero cancellation are present. Time-variant filters of the gain-varying class are used to realize the required optimum weighting functions of finite width. It is shown how nonfinite-width weighting functions of some time-invariant filters can be modified into finite-width functions by switching. These switched-gain time-variant filters are somewhat limited in choice of weighting functions. A general processing system can be realized employing filters with continuously time-variant elements. In particular, a gain-varying element (i.e., an analog multiplier) can be used in conjunction with an integrator to realize arbitrary weighting functions, and therefore the theoretically maximum signal-to-noise ratio. The system is time-variant only for the noise and not for the signal, so that it does not require high precision of the time-variant element. The system output is independent of the gating interval, and does not require precise timing. A method for evaluation of such systems in terms of noise, ballistic deficit and sensitivity to parameter variations is given. (auth)

40450 HYPERCRYOGENIC DETECTOR-FET UNIT: CORE OF HIGH-RESOLUTION SPECTROMETER. Elad, E.; Nakamura, M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 477-85(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A hypercryogenic high-resolution x-ray and γ-ray spectrometer consists of a lithium-drifted germanium detector and a germanium-junction field-effect transistor (JFET) preamplifier. The detector is operated at its optimum temperature, which is in the range of 10–30°K. The JFET's are operated at liquid helium temperature. This results in 0.28 keV fwhm preamplifier resolution with a slope of 0.018 keV/pF. Resolutions of the order of 0.4 keV are obtained with low capacitance detectors for low-energy x rays. The γ rays of ^{57}Co are measured with 0.68 keV fwhm. The described spectrometer was used to study some aspects of the trapping effects in germanium detectors. (auth)

40451 COMPTON SUPPRESSION USING PULSE-SHAPE DISCRIMINATION AND ANTICOINCIDENCE TECHNIQUES. Swinth, K. L.; Philipp, L. D.; Hoitink, N. C. (Battelle-Northwest, Richland, Wash.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 486-90(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The suppression of the background continuum in solid-state detectors by anticoincidence and/or pulse-shape discrimination aids in the interpretation of spectra and enhances the peak to Compton ratio. Studies were performed with both ^{137}Cs and ^{59}Fe sources. For the ^{59}Fe source, an average reduction of 85% in the continuum resulted using a planar diode 110 mm^2 by 2.4 mm deep in an anticoincidence annulus of NaI(Tl). Both the distribution and number of events rejected varies with the amplifier shaping time constants. Results are compared with those obtained by other investigators. (auth)

40452 THE POSSIBILITIES OF USING CdTe AS A GAMMA SPECTROMETER. Akutagawa, W.; Zanio, K. (Hughes Research Labs., Malibu, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 266-74(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Photopeaks have been resolved from monoenergetic gammas within the 122 to 840 keV range using 40 mm^3 surface barrier CdTe detectors operated at room temperature and under less than full collection conditions. Presently available CdTe exhibits heavy charge trapping and the gamma spectra reflect the effect of trapping and detrapping under changes of temperature, bias, and clipping time. (auth)

40453 STUDIES OF DETECTION EFFICIENCIES AND OPERATING CHARACTERISTICS OF Ge(Li) DETECTORS. Cline, J. E. (Idaho Nuclear Corp., Idaho Falls). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 198-213(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The rapidly expanding use of Ge(Li) detectors in all fields of gamma-ray spectroscopy has led to a need for information from which experimenters may effectively select the best detector for their special needs. This is necessitated because of the large variety of detector sizes and configurations which are currently available and the lack of standardization of sizes. Several criteria should be considered in the selection of a detector for a specific application. Among these are: 1) detection efficiency, 2) charge collection efficiency, which gives rise to abnormal peak broadening as a function of gamma-ray energy as well as to asymmetric peak shapes, 3) timing characteristics for coincidence applications, and 4) energy resolution which is one of the measures of the ability to identify a weak gamma-ray in the presence of strong higher-energy gamma rays. We have measured these characteristics for several planar and open-ended and five-sided coaxial detectors. Absolute full-energy peak, double-escape peak and single-escape peak efficiencies were obtained for gamma-ray energies from 30 keV to 11 MeV. For planar devices, the effects of thickness and cross-sectional area of the depleted volume have been investigated. Some studies have been made of the problems involved in measuring gamma-ray intensities. These include measurements of the counter "edge effects" by a comparison of the efficiency curves obtained at different source-detector distances. Other studies involve random and real coincidence summing effects which are counting-rate and geometry-dependent effects. (auth)

40454 LIQUID SCINTILLATION SPECTROMETER. Pathol. Biol., Sem. Hop., 16: 233-4(Feb, 1968). (In French).

A new apparatus, the ABAC, type SL40, produced by Intertechnique S.A., is described. It combines a high-performance

spectrometer and a computer organized around a memory (1024 words, ferrite core). The spectrometer may be operated in several modes: mixtures of 2 isotopes, or single isotopes. Potentiometric regulation of thresholds may be adjusted independently, and constant-yield counting of samples of different decay is possible. The detect circuit of the detector has τ = 20 nsec, and can be operated between −5 and 15°C at ±0.5°C. The counter handles 200 samples. The computer is preprogrammed; 7 programs may be selected and special programs can be furnished. The memory can take 4 quenching curves obtained by a ratio method; the computer can produce precise yields corrected for background and quenching, or print disintegrations/min for singly and doubly labeled samples, or print ratios of activities for doubly labeled samples with statistical error. The instrument is reliable because of the use of integrated circuits; 10^6 complete cycles were taken in testing without problems. (BBB)

40455 A NaI(Tl) SPECTROMETER FOR γ-RAYS IN THE GeV RANGE. Lakin, W. A.; Hughes, E. B.; Hofstadter, R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.). Trans. Nucl. Sci., NS-15: No. 3, 82-3(June 1968).

It is shown that NaI(Tl) scintillation spectrometer is capable of measuring electron and, therefore, gamma ray energies with a resolution of the order of ±1% at 2 to 12 GeV. Additional tests show that this resolution is maintained over a circle of 5 in. diameter centered about the crystal axis for electrons incident normal to the crystal face. (auth)

40456 ANALOG-DIGITAL CONVERTER (Engineering Materials). (California Univ., Berkeley). (CAPE-1742).

148 drawings.

A high-speed 4096-channel, 12-bit analog-digital converter (ADC) for pulse height analysis is described. The unit accepts input pulses less than 1 μsec long and produces a 12-bit digital output in a register in less than 25 μsec. Random pedestal technique is employed resulting in essentially equal channel widths from channel 40 to 4000. Integrated circuits are used for all digital operations. The unit is designed for convenient linking to a computer using program interrupt or direct memory access facilities, but it can be operated with any memory unit. The ADC, controlled by PDP-5 and PDP-7, is used in nuclear spectroscopy experiments. (For details see TID-4100 Suppl. 46). (F.S.)

40457 TWO MODIFICATIONS OF THE MAGNETIC SYSTEM OF A CHARGED-PARTICLE ANALYZER. Basargin, Yu. G. Dokl. Akad. Nauk SSSR, 179: 1074-5(Apr. 11, 1968). (In Russian).

The commonly used wide-range charged-particle spectrometers with dual second-order focusing in a homogeneous magnetic field are limited in their application, because they do not have vertical focusing and exhibit a second-order aberration for the radial motion. H. A. Enge's recently described wide-range magnetic analyzer must operate with a complicated three-section magnetic system. It is proposed to simplify the design of this instrument, using a magnetic system possessing only two sections; it is assumed that the field changes abruptly at the section boundary. A double-focusing spectrometer with improved resolution is also described. The spherical aberration of the instrument is compensated by a gap in the magnet or the curvature of the section boundary. (TTT)

40458 SCINTILLATOR FOR THE MOESSBAUER SPECTROMETER. Salakhutdinov, N.; Solodilov, V. E.; Kalmakov, A. A. (Inst. of Automation and Remote Control, Moscow). Izv. Akad. Nauk Uzb. SSR, Ser. Tekh. Nauk, No. 5, 10-14(1967). (In Russian).

An NaI(Tl) scintillator with an FEU-13-type photomultiplier is described, which is used as a transducer for a spectrometer designed to measure Mössbauer radiation sources not exceeding 100 keV. A NaI(Tl) crystal was used as the scintillator because the amplitude of light scintillations in NaI(Tl) is considerably greater than in other scintillators. To improve the natural energy resolution of the crystal, its thickness was reduced to 2 mm. In selecting the photomultiplier, special effect was made to obtain minimal dark current. Since the measured energy was 23.8 keV for ^{119m}Sn and 14.4 keV for ^{57}Fe, the equivalent noise energy of the photomultiplier had to be below these levels. It was experimentally established that the noise level for the FEU-13 photomultiplier with a 10^5 multiplication factor lies in the region of 5−7 keV at a counting rate of 50 pulse/sec and 15−17 keV at 1 pulse/sec. The basic characteristics of the photomultiplier were measured after the amplification stage. The S/N ratio was 28 and the pulse width was 1.2 μ sec for a 33-kohm load. (ATD)

High Energy Physics Instrumentation

Refer also to abstract 41727.

40459 (BNL-12679) FLYING IMAGE DIGITIZER. A HIGH-SPEED DIGITIZER FOR TRACK CHAMBER PHOTOGRAPHS. Kawaguti, Minato (Brookhaven National Lab., Upton, N. Y.). [nd]. 10p. (CONF-680906-1). Dep. CFSTI.

From International Symposium on Nuclear Electronics, Versailles, France.

A new method adequate to digitize photographs of track chambers, especially of bubble chambers, in significantly increased rate compared to the current HPD is proposed. The device consists of a thousand solid-state photodetectors arranged on a straight line which function independently, and of rotating mirrors which sweep the enlarged illuminated image of a film across the detectors. The associated problem of pattern recognition which is important in digesting the information efficiently is also discussed. (auth)

40460 (DESY-68/30) MEASUREMENT OF THE LIMIT OF SENSITIVITY OF HYDROGEN IN A BUBBLE CHAMBER AND CALIBRATION OF PRESSURE GAUGES. Horlitz, G.; Wolff, S. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany); Harigel, G. (European Organization for Nuclear Research, Geneva (Switzerland)). June 1968. 15p. Dep.

A new method of calibrating pressure gages in bubble chambers under operating conditions is described. Starting with different static pressures p_s greater than the vapor pressure p_v, the dynamic pressure in a bubble chamber is reduced to an arbitrary, fixed value p(b,T). At a given temperature T, the appearance of this pressure p(b,T) is indicated by a constant bubble density b. A plot of the signal U of a pressure transducer (corresponding to the pressure drop $p_s - p(b,T)$) against the static pressure p_s gives a straight line for every single b = const. The slope of these lines is equal to the sensitivity of the gauge. The extrapolated experimental line intersects the axis U = 0 in the point $p_s = p(b,T)$, which is independent of the calibration factor of the transducer. In an 85 cm bubble chamber, p(b,T) has been measured in the temperature interval 24.5 < T < 28.0°K with b = 0, which represents the limit of sensitivity in a p-T diagram for relativistic electrons. (auth)

40461 HELIUM DISCHARGE-CONDENSATION CHAMBER. Mandzhavidze, Z. Sh.; Dzhavrishvili, A. K.; Roinishvili, V. N. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR)(Engl. Transl.), 7: 294-5(May 20, 1968).

The feasibility of using a discharge-condensation chamber filled with helium for particle track detection is investigated. Some operating characteristics for a chamber of 30 cm. diameter and 8 cm. depth are given. (L.B.S.)

40462 INVESTIGATION INTO THE RESPONSE AND SENSITIVE REGION OF A WIRE-PLATE SPARK COUNTER IN AIR. Dunton, P. C.; Simons, H. A. B. (Royal Free Hospital, London). Phys. Med. Biol., 13: 383-92(July 1968).

The sensitivity and response of a wire anode and earthed plate spark counter were determined for a single wire and a simulated infinite array of parallel wires with spacings of 1 mm and 0.5 mm between the wires. The regions of sensitivity were found using a finely collimated α-particle source. The response curves are shown, and for the array give sensitivities of 30% and 40% of the total area, for spacings of 1 mm and 0.5 mm respectively between the wires. The electric field was calculated for the three cases and the magnitude of the field is shown at positions around the wire. A threshold field for sparking of 7×10^4 volt cm^{-1} was found for the single and 1 mm spaced counters, but was as high as 12×10^4 volt cm^{-1} for the 0.5 mm spacing. (auth)

40463 TRANSMISSION-LINE TYPE LARGE DIGITAL SPARK CHAMBERS. Fischer, Joachim; Shibata, Shinkichi (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 572-8(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A transmission-line type digital spark chamber is described consisting of electrodes of etched wires on an "H" Film substrate, backed by a bonded metal foil. The foils are pulsed from one end and are terminated and connected to the wires at the other end. The chamber gives uniform response. The size of the spark was investigated for several hv pulse shapes and amplitudes. The efficiency is high even to multiple sparks because the spark impedance in gases with quenching vapors is high relative to the line impedance, and because of the strong coupling to the pulsed foils. (auth)

40464 DESIGN AND PERFORMANCE OF 1.5 m^2 WIRE SPARK CHAMBERS. Fryberger, D.; Horton, J.; Jensen, D.; Neumann, M.; Nunamaker, T.; Shea, T.; Telegdi, V. (Univ. of Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 579-85(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A group of six wire spark chambers is described, the largest of which is 1.5 m^2. These chambers are presently being used at the Argonne National Laboratory in an experiment to study the interference between L_L and K_S 2π decay amplitudes. The chambers have an air equivalent scattering length of approximately 30 cm of air. They are constructed of crossed 6-mil duraluminum wires, with spacing of 24/inch. Both Aclar and Mylar films are used to cover the chambers. The frames are $\frac{1}{4}$ in. glass epoxy G-10, pre-stressed and reinforced by four pieces of rectangular aluminum tubing. The wires are brought out on both ends of the frame, where the memory planes and resistive terminations are clamped on. Banks of three chambers are mounted as portable units; for each bank, the overall wire positioning error is less than 0.2 mm. In order to improve the pulsing properties each wire is pulsed from both ends, i.e., through the readout core on one end and a 500-ohm termination on the other. This resistance is large enough to prevent current robbing from the core once a spark is formed, yet small enough to pass the main high voltage pulse. The shape of the pulse as applied to the chambers is roughly triangular, ranging from 120 to 200 nsec in width (depending on the size of the chamber). Readout from both the X and Y planes is obtained by means of shielded magnetic cores that operate in fields up to 400 Gauss. Core memory planes are of an endless design with modules of either 28 in. or $13\frac{1}{3}$ in. lengths. Detailed performance checks yield a resolution of 1 mm with a chamber efficiency of 99% and 4% spurious sparks. (auth)

40465 LOW-COST LARGE-SCALE MAGNETOSTRICTIVE SPARK CHAMBER DIGITIZING SYSTEM. Kirsten, Frederick A.; Rudden, Robert J. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 586-90 (June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A compact low-cost large-scale digitizing system for spark chambers has been developed. This system uses a single clocked scaler and a high-speed integrated-circuit memory. The number of words of memory required is equal to the sum of the number of sparks expected in all the chamber gaps plus the number of start fiducial pulses expected (one per transducer channel). Each magnetostrictive transducer is assigned certain addresses in the memory. As pulses arrive from the sensors, the current contents of the scaler are stored in the appropriate preassigned addresses of the memory. To avoid synchronization problems, a Gray-code scaler is used. The memory is made of 16-bit integrated-circuit scratch pad memory elements. The system could be operated with the clock frequencies of up to 40 MHz. The storage capacity of the system is expandable. This system is compared with other known systems.

40466 HIGH SENSITIVITY WIRE SPARK CHAMBER READOUT USEFUL IN STRONG MAGNETIC FIELDS. Neumann, M.; Nunamaker, T. A. (Univ. of Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 591-3(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A developmental wire spark chamber is described which can detect extremely weak discharges. The readout circuits are not affected by magnetic fields, thus offering the opportunity to use such chambers in strong magnetic field areas. Each wire in the chamber is in series with a memory capacitor. A discharge in the chamber charges this capacitor. However, the displacement current's charge, associated with pulsing the chamber, averages to zero, thus making it possible to detect very weak discharges. Readout consists of discharging each memory capacitor with a Field Effect Transistor (FET) into a digital scanner. Preliminary tests indicate that a charge gain of 10^6 to 10^7 in the chamber is the lower limit of useful operation of the present capacitor–FET readout combination. By using small diameter wires in the chamber, discharges as low as 0.02μ Coulombs will give efficient operation. (auth)

40467 NON-MAGNETIC DIGITIZED READOUTS FOR SPARK CHAMBERS. Droege, Thomas F. (Princeton Univ., N. J.); Perez-Mendez, Victor; Stoker, Gerald. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 594-600(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Magnetostrictive spark chambers are operated with difficulty in magnetic fields. By inducing secondary sparks to a pickup wire, signals can be generated which are similar to those from a magnetostrictive chamber but which are unaffected by magnetic fields. Piezoelectric pickup transducers complete a field insensitive digital spark chamber system. (auth)

40468 BUBBLE CHAMBERS. Aleksandrov, Yu. A.; Voronov, G. S.; Gorbunkov, V. M.; Delone, N. B.; Nechaev, Yu. I. Bloomington, Ind., Indiana University Press, 1967. 381p. $12.50.

Translated from Puzyr'kovyye Kamery.

The theory, historical development, design, operation, and research applications of bubble chambers and auxiliary apparatus are discussed in three parts. In the first part, the generation of vapor bubbles by charged particles in superheated vapor, nucleation and the bubble formation process in liquids and gas–liquid mixtures growth and concentration of bubbles, and efficiency of bubble chambers are discussed. In part two, the media mechanisms of pressure variation, illumination and photography, auxiliary apparatus, hydrogen chambers, and construction differences of various types of chambers are examined. In part three, particle identification from track measurements, measurements of particle velocities from track density, and instrumentation in experiments are reviewed. (B.G.D.)

Radiation Dosimeters

Refer also to abstract 40773.

40469 (AD-668109) FREE RADICAL YIELDS IN POLYTETRAFLUOROETHYLENE AS THE BASIS FOR A RADIATION DOSIMETER. Report for June 1965–September 1967. Judeikis, Henry S.; Hedgpeth, Herbert; Siegel, Seymour (Aerospace Corp., El Segundo, Calif.). Feb. 1968. Contract F04695-67-C-0158. 39p. (TR-0158(3250-20)-6; SAMSO-TR-68-140). CFSTI.

Exposure of polytetrafluoroethylene (PTFE) to ionizing radiation results in chemical degradation of the polymer and formation of long-lived free radicals. The paper describes the use of quantitative measurements of the electron spin resonance (ESR) spectra of the free radical produced in irradiated PTFE to determine radical yields and attempts to correlate these radical yields with the absorbed radiation dose. The experimental results indicate sufficient correlation over the experimental rad range to permit use of PTFE as a passive radiation dosimeter. The advantages inherent in the use of the PTFE dosimeter for the measurement of low energy electromagnetic or particulate radiation are also discussed. Energy deposition as a function of depth from the incident surface can be determined by sectioning of the polymer after irradiation. The resulting dose-depth curves can then be used to obtain spectral and profile data from polychromatic sources. (auth) (USGRDR)

40470 STABILIZED RADIATION DOSIMETERS. Holm, Niels W.; Jarrett, Robert D. (to Secretary of the Army). U. S. Patent 3,390,099. June 25, 1968. Filed Sept. 15, 1965.

A radiation dosimeter useful in the range of from 50,000 to 1,000,000 rads consisting of an air saturated solution of ferrous sulfate, cupric sulfate and sulfuric acid, which is stabilized against oxidation-reduction reactions which alter the optical density of the solution by irradiation of the freshly prepared solution by high energy ionizing radiation in the range of 200,000 to 400,000 rads is described. (auth)

40471 CHARACTERISTICS OF $CaSO_4$(Mn) FILM PHOSPHORS FOR USE AS THERMOLUMINESCENT DOSIMETER. Nakajima, Toshiyuki (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 360-4(July 1968).

A thermoluminescent dosimeter of the thin film of $CaSO_4$(Mn) was prepared and its optical and dosimetric properties were investigated. Glow curve, transmission and thermoluminescent spectra as optical properties of the film phosphors were measured, and these properties were suitable for the dosimetry. Energy dependence, linearity of the dose and the fading as the dosimetric properties were measured. Measurable minimum dose of the film phosphors was about 10^{-3} R and their energy dependence on the low or high energy electrons was found. (auth)

40472 INHERENT BACKGROUND REDUCTION FOR THE EG AND G MODEL TL-12 CaF_2(Mn) THERMOLUMINESCENT DOSIMETER. Oberhofer, M. (EURATOM-CCR, Ispra, Italy). Health Phys., 15: 156-8(Aug. 1968).

It is stated that values indicated by the above dosimeters in use at Ispra have been rather high, partly due to inherent radioactivity, particularly ^{40}K in the glass envelope of the dosimeter. In order to obtain more absolute dose values the instruments were partially dismantled and use made of glass free from ^{40}K. (UK)

40473 RADIATION RESPONSE OF LiF AT LOW DOSES. Wallace, D. M.; Watkins, L. L. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Health Phys., 15: 159-60(Aug. 1968).

Reference is made to the note by Hendee (Health Phys. 13:

1235(1967)) on the radiation response of LiF at low doses. No evidence was found of such non-linear response for material in use at AWRE. (UK)

40474 THE MEASUREMENT OF LOW ENERGY X-RAYS. III. FERROUS SULPHATE G-VALUES. Law, J.; Redpath, A. T. (Edinburgh Univ.). Phys. Med. Biol., 13: 371-82(July 1968).

A total absorption calorimeter was used to measure energy flux in low energy x-ray beams from a Be-window Machlett tube. The beams were then totally absorbed in ferrous sulphate (Fricke) dosimeter solution and measurement of total ferric ion production used to calculate G-values. The results using 0.8N-H_2SO_4 solutions were 13.1 ± 0.2 for 20 kv_p, 13.0 ± 0.2 for 15 kv_p and 12.9 ± 0.3 for 10 kv_p beams. In 0.1N-H_2SO_4 the result was 13.0 ± 0.2 for a 20 kv_p beam. (auth) (UK)

Radiometric Instruments

40475 (KFKI-15/1968) CODE FOR CALCULATION CONCERNING NEUTRON MOISTURE MEASUREMENTS. Vertes, P.; Nagy, A. Z. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). June 12, 1968. 8p. Dep.

A short description of a code, written in 1CT-algol, for calculating the number of detected neutrons originated from a point source and slowed-down in an infinite homogeneous mixture of any dry material and water, is given. The required input information, the possible outputs and the listing are also presented. (auth)

40476 THICKNESS MEASURING GAUGE COMPRISING A RADIOACTIVE SOURCE AND SOLID STATE RADIATION DETECTOR. Chope, Henry R. (to Industrial Nucleonics Corp.). U. S. Patent 3,387,133. June 4, 1968. Filed Feb. 3, 1964.

A radiometric instrument which may be used for measuring mechanical displacements, pressure changes, and thickness of materials is described. A semiconductor detector is used. (W.H.K.)

40477 SLOW-NEUTRON DETECTORS FOR RADIOACTIVE-LOGGING BOREHOLE INSTRUMENTS. Vedekhin, A. F. Razved. Geofiz., No. 21, 120-7(1967). (In Russian).

The faults, virtues, and designs of various slow-neutron (thermal and epithermal) detectors for borehole equipment used in radioactive logging that have been developed since 1958 are described. These detectors, utilizing as luminous compounds zinc sulfate activated by silver and boron anhydride, lithium glass, and single crystals of lithium iodide activated by europium. They have high sensitivity to slow neutrons, mechanical strength, high operational reliability under conditions of 98% humidity of the medium at temperatures up to 100°C, and a high light yield. (ATD)

Miscellaneous Instruments and Components

Refer also to abstracts 40248, 40293, 40809, 41118, 41526, and 42343.

40478 (AD-668451) INSTRUMENTATION FOR SOIL MOTION STUDIES. Technical Report, January 1966-September 1967. Fernandez, Herbert M.; Bunker, Robert B. (Air Force Special Weapons Center, Kirtland AFB, N. Mex.). Apr. 1968. 60p. (AFSWC-TR-67-30). CFSTI.

The present instrumentation being used by AFSWC in High Explosive Simulation Technique (HEST) tests is presented in this report. Outlines of some of the current developments in soil motion transducers are also included. This instrumentation is used to gather the data needed to analyze soil motion characteristics from an air-induced shock generated by a simulated nuclear blast. The physical quantities measured by this instrumentation include pressure, acceleration, velocity, displacement, soil strain, soil stress, and shock wave velocity. The instrumentation discussed in this report is mainly an adaptation of standard configurations and techniques to meet the requirement of gathering data under a severe HEST environment. This adaptation is required because the input shock generated in a HEST test is of a transient nature and of high-amplitude levels; therefore, the shock presents unique problems in instrumentation. Aspects cover the instrumentation needed to gather data from a HEST test, including the transducers, the transmission lines, the signal conditioning, and calibrating systems, and the recording and reproducing systems. (auth) (USGRDR)

40479 (AI-AEC-Memo-12710) ZAPPER: A DEVICE FOR REPAIRING OPEN-CIRCUITED THERMOCOUPLES. Babbe, E. L. (Atomics International, Canoga Park, Calif.). June 3, 1968. Contract AT(04-3)-701. 6p. Dep. CFSTI.

A device to weld remote breaks in thermocouples has been developed. It is an adjustable capacitive discharge welding machine capable of repairing thermocouples attached to in-pile irradiation experiments where accessibility is not possible. (auth)

40480 (APDA-210(Add.)) DEVELOPMENT OF THE UNDER-SODIUM ULTRASONIC SCANNER. Scott, C. C.; Kovac, L. R. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1968. Contract AT(11-1)-865. 14p. Dep. CFSTI.

This report is an addendum to APDA-210, "Development of the Under-Sodium Ultrasonic Scanner." The previous report covered the feasibility studies that preceded development of the single narrow-beam transducer scanning system, as well as the developmental work for that system. This addendum presents knowledge gained in the program subsequent to the issuance of that report. Areas discussed include the following: feasibility studies for the acoustic image conversion system; program for the design and demonstration of a prototype under-sodium ultrasonic scanner; bonding studies for acoustic transducers; and acoustic attenuation as a function of impurities in sodium. (auth)

40481 (CEA-R-3440) TEST DE FONCTIONNEMENT ET MESURE DU TEMPS DE RESOLUTION D'UN ENSEMBLE DE COMPTAGE. (Operational Testing and Measurement of the Resolving Time of a Counting Assembly). Manent, Georges; de Scheemaecker, Jacques (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Jan. 1968. 25p. (In French). Dep.

An experiment is described which constitutes a very sensitive test of the satisfactory operation of a counting assembly. It makes it possible to measure the resolving time of an assembly to an accuracy of 1 per cent. Examples are presented which show the sensitivity of the test. (auth)

40482 (DESY-68/26) ULTRAHIGH VACUUM REFLECTOMETER FOR USE WITH EXTREME ULTRAVIOLET SYNCHROTRON RADIATION. Feuerbacher, B.; Godwin, R. P.; Skibowski, M. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1968. 21p. Dep.

An ultrahigh vacuum reflectometer is described. It may be used for studies of reflectance, transmittance, and photoemission on samples evaporated in situ. The angle of incidence can be varied from 0 to ±90° in steps of 7.5° for sample and detector independently. The whole system can be rotated about the axis of the incident light for study of polarization effects. With the highly polarized continuum of synchrotron radiation as a light source and a normal incidence monochromator the reflectometer allows measurements in the extreme ultraviolet for wavelengths down to 300 Å for s and p polarized light. (auth)

40483 (DP-1154) DIGITAL SYSTEM FOR FAST PRINTOUT OF ANALYZER MEMORY. Byrd, J. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1968. Contract AT(07-2)-1. 12p. Dep. CFSTI.

A digital control circuit and code converter was designed to print out the binary data stored in a 4096-channel spectrum analyzer memory. Data and channel identification are printed in decimal form with a high speed digital printer. The entire memory of any multiple of 256-channel subgroups can be printed parallel at the rate of 40 lines per second. (auth)

40484 (INR-P-897) NEUTRON POLARIMETER WITH HIGH-ENERGY RESOLUTION. Sieminski, M.; Wilhelmi, Z.; Zych, W.; Zupranski, P. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 11p. Dep.

A new type of neutron polarimeter utilizing the n-alpha scattering as polarization analyzer is described. The energy resolution obtained for 14-MeV neutrons was about 14%. (auth)

40485 (INR-904) DETERMINATION OF STATISTICAL PARAMETERS OF THE DOUBLE-TRIPLE COINCIDENCE CIRCUIT. Kalisz, J. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 15p. (In Polish). Dep.

A triple coincidence circuit is considered, which consists of two double coincidence circuits connected in series. The probability density of registration time of the first double coincidence circuit and the coincidence curve of the whole triple coincidence circuit are determined analytically. Two methods are presented for determination of statistical parameters of the double-triple coincidence circuit on the basis of the empirical coincidence curve. (auth)

40486 (LA-3939) THE ISOPIESTIC BALANCE. Elliott, Guy R. B. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Contract W-7405-eng-36. 20p. Dep. CFSTI.

Materials, dimensions, and construction of the isopiestic balance for both solids and liquids are described as it was used in 1963. The precision of performance as of that period is discussed. (auth)

40487 (UUIP-586) COMPUTER DESIGN AND OPTIMIZATION OF IRON CORED PARTICLE FOCUSING DEVICES. Olsen, Bengt; Besev, Cengiz (Uppsala Univ. (Sweden). Inst. of Physics); Colonias, John S. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1968. 38p. Dep.

A method is described by which the design of particle focusing devices may be facilitated and optimized by using high speed digital devices and modern computing techniques. It is shown that the method described is economical, precise and general, and it also provides the experimenter with the flexibility of designing various models prior to the actual construction of the final instrument. A computer program has been prepared which allows the experimenter to completely design particle focusing devices with or without iron. The programs make use of modern on-line computing techniques to allow the user to interact with the digital device and direct the progress of the solution based on information displayed on a cathode ray tube. Communication with the computer is made via a light pen and a teletype. It is also shown that the computed fields and the focusing properties of the directional correlation spectrometer, used as an example, compare favorably with those measured. (auth)

40488 STUDIES OF APPLICATIONS OF NUMERICAL AND ANALOG COMPUTERS IN NUCLEAR PHYSICS AND TECHNIQUES. Solov'ev, G. N. Issled. Primen. Tsifrovykh Analogovykh Vychisl. Mash. Yad. Fiz. Tekh., Sb. Statei, No. 1, 3-116(1967). (In Russian).

Twelve articles are included on the studies carried out by the Moscow Inst. of Physical Engineering on applications of digital and analog computers in nuclear physics and technology. Programming of physical experiments with high-energy accelerators, development of special analog computers for the automatic control of linear electron accelerators, and theoretical treatment of data with analog computers are analyzed. Thirty-five references are included. (R.V.J.)

40489 ION SOURCE AND ACCELERATOR ASSEMBLY FOR A TIME-OF-FLIGHT MASS SPECTROMETER. Gohlke, Roland S.; Karle, Franklin J. (to Dow Chemical Co.). U. S. Patent 3,390,264. June 25, 1968. Filed Dec. 4, 1964.

An electrostatic time-of-flight mass spectrometer apparatus in which a ribbon of electrons is brought to sharp focus along the longitudinal axis of the ion source, ion acceleration and flight tube assembly is described. The ions produced by the collision of the electron beam with the sample in the ion source are accelerated by means of substantially uniform accelerating fields through collimating slits in the ion source, ion accelerator, and flight tube and impinge on a detector which usually is an electron multiplier device. (auth)

40490 ION CYCLOTRON RESONANCE MASS SPECTROMETER HAVING MEANS FOR DETECTING THE ENERGY ABSORBED BY RESONANT IONS. Llewellyn, Peter M. (to Varian Associates). U. S. Patent 3,390,265. June 25, 1968. Filed May 17, 1965.

A spectrometer is described which employs ion cyclotron resonance and energy absorption in mass analysis. In an evacuated envelope ions are formed in the first of two regions which are subjected to static magnetic and electric fields disposed at right angles to each other and to the common axis of the two regions. by the interaction of the fields the ions are caused to move with cycloidal motion into the second region which is additionally subjected to an oscillating electric field in the same direction as the static field. The ions in resonance with the oscillating field absorb energy therefrom and separate from the non-resonant ions. The energy absorbed by the resonant ions is then detected as a measure of the resonant ions. (auth)

40491 CYCLOTRONIC MASS SPECTROMETER WITH NON-ACCELERATED SYNCHRONOUS ION. Mercea, V. (Inst. for Atomic Physics, Cluj). Isotopenpraxis, 4: 128-33(Apr. 1968).

The theory and operation of a cyclotronic resonance mass spectrometer based on the fact that the synchrotronous ion is neither accelerated nor decelerated are presented. It is shown that its resolving power is the same with that of a device working with n distinct modulators, having the advantage of a much higher intensity of the ionic current. A practical example for the separation of a multiplet of mass 30 is computed and discussed. (auth)

40492 LIQUID METAL VAPOR QUALITY METER (Engineering Materials). (Bendix Corp., Southfield, Mich. Research Labs. Div.). (CAPE-1749).

A liquid metal vapor quality meter, which is a device used to sense the quality of K vapor, is described. Quality is the ratio of the vapor mass to the total mass of the vapor-liquid mixture. The meter consists of a delay line oscillator, a pressure transducer and associated amplifier, and a frequency meter. A frequency range between 900 and 980 Hz was established for quality ranging from 80 to 100% for K vapor at 1400°F. An expected frequency range between 1100 and 1180 Hz, for the quality range from 80 to 100% was indicated by test data using NaK-18. Resolution was 4 Hz for each 1% change of quality. As the temperature increases the output frequency decreases but the resolution is still several Hz per 1% change of quality. The meter is fabricated from stainless steel by diffusion bonding. (For details see TID-4100 Suppl. 47). (F.S.)

40493 ULTRASONIC MANIPULATING SYSTEM (Engineering Materials). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). (CAPE-1747).

7 drawings.

Equipment used in taking measurements in an ultrasonic method for nondestructively detecting radiation induced embrittlement in pressure vessel steels is described. A constant speed motor translates the test specimens past the test crystals. Test crystals are placed below test specimens to maintain correct aiming alignment. The critical angle method is used. The method utilizes Rayleigh (surface waves) and is sensitive only to surface and subsurface physical properties changed by neutron irradiation. Measurements are made at $2\frac{1}{4}$ MHz. (For details see TID-4100 Suppl. 47). (F.S.)

40494 ANALOG PULSE DIVIDER (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1748).

1 drawing.

An analog pulse divider using field-effect transistors is described. The output pulse has an amplitude proportional to the ratio of the amplitudes of two unipolar input pulses. The instrument is capable of handling simultaneous pulses as well as those separated by several microseconds. The divider can be used in conjunction with position-sensitive, charged particle detectors. (For details see TID-4100 Suppl. 47). (F.S.)

40495 NUMERICAL INVESTIGATIONS IN NUCLEAR AND ATOMIC SPECTROSCOPY. METHODS FOR DESIGN AND OPTIMIZATION OF PARTICLE FOCUSSING DEVICES, THEORETICAL STUDIES OF PERTURBED ANGULAR CORRELATIONS, AND EVALUATION OF EXPERIMENTAL DATA. Olsen, Bengt. Uppsala, Univ. of Uppsala, 1968. 12p.

Thesis.

A review of the use of computers for the design and optimization of charged-particle focusing systems, theoretical studies of perturbed angular correlations, and numerical analysis of the time spectrum of delayed coincidences is presented. (W.H.K.)

40496 PULSE-HEIGHT ANALYZER FOR SPACE APPLICATION. Schneider, W. J. (California Inst. of Tech., Pasadena). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 556-61(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A number of investigations, suitable to be performed from space vehicles, make use of nuclear pulse spectrometry as an instrumentation method. The Jet Propulsion Laboratory program described here was designed to provide a pulse-height analyzer of sufficient precision and versatility as to be suitable for any of a number of such spaceborne investigations. The analyzer may be commanded inflight to perform pulse-height analysis, time analysis, or multiparameter analysis. Instruction storage, data storage, and data readout, including a data compression option, are provided internally. (auth)

40497 CURRENT-MODE TRIGGER PULSE GENERATOR FOR FAST COINCIDENCE CIRCUITS. Leung, C. Y.; Paul, D. A. L. (Univ. of Toronto). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 531-5(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The design and philosophy of a new current-mode trigger pulse generator are described. The pulse generator uses two transistors in a coupled-emitter configuration and only ordinary components. The output impedance at collectors is 93 ohms though this may be reduced where it is desired to match other transmission line impedances. Rise time is less than 3 nanoseconds with jitter in the 10^{-11} second range. Pulse output is ±2.5 volts and extremely clean and square with little undershoot or overshoot. Pulse length may be chosen, in the normal way, to be from ~10 nsec up to microseconds. The circuit may be retriggered as soon as the output has recovered to zero. Its layout will be discussed and also its use as a replacement for limiter circuits in fast coincidence measurements. (auth)

40498 FLUCTUATION NOISE AND DEVICE STRUCTURE. Dissing, E. (Aktiebolaget Atomenergi, Studsvik, Sweden). IEEE

(Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 471-6(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A generalized formula is developed for the power spectrum of the short-circuit noise current of three-terminal devices. The power spectrum is shown to be determined by a factor 2-kTg/ηIe which can never be greater than 2 and never smaller than 1. This factor corresponds to the various smoothing factors (F, Q, H. . .) normally used when device noise is described by means of the shot noise associated with the dc current flowing through the device or by the measured transconductance. The limiting values for these factors are probably not device geometry determined but rather depend on the fundamental mechanism responsible for the discrepancy between the measured and the theoretically highest possible value Ie/kT of the transconductance. kTg/ηIe, the internal feedback factor, describes the reduction of transconductance owing to space charge or bulk resistance in the current path while η is a structural constant of the device related to the efficiency of the gate voltage control. The utility of the generalized fluctuation noise formula is demonstrated for different devices at various temperatures and the measured noise power spectrum is used for the determination of η. (auth)

40499 THE TRANSFER METHOD, A NEW TECHNIQUE FOR THE SENSITIZATION OF PHOTOELECTRIC TUBES. Pietri, G. (Laboratoires d'Electronique et de Physique Appliquee, Limeil, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 171-8(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The application of a transfer technique to the processing of various types of phototubes is described. The advantages of this method are discussed with reference to various classes of tubes. By processing the photocathode separately, it is possible to improve the sensitivity, uniformity, reproducibility and stability with time, and to reduce field emission and dark current of the assembled tube. (auth)

40500 REVERSE EPITAXIAL SILICON DIODE FOR HYBRID PHOTOMULTIPLIER TUBE. Fertin, J. (RTC La Radiotechnique Compelec, Caen, France); Lach, B.; Meuleman, J.; Dupuis, J.; L'Hermite; Petit, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 179-89(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A new silicon multiplying structure, of the reverse epitaxial type, suitable for use in conjunction with a photocathode of a photomultiplier tube decreases the switching time for high current pulses. To obtain linear output current of 10 amps into a 50Ω load and switching times of the order of 10^{-9} sec, a passivated over-polarized diode of 30 μ thickness was employed. The electrostatic focusing of the hybrid multiplier to decrease as much as possible the transit time (10^{-12} sec) of the 12 keV photoelectrons and transit time fluctuations was studied. To protect the diode junction edge from cesium and antimony vapor, the diode is masked while these materials are deposited on the photo surface. The photocathode and the diode were then heated under the same high vacuum and the whole structure sealed by the transfer method. With a 300Ω cm silicon structure, linear currents to 4 amperes are obtained with a current risetime of 1.3×10^{-9} sec. (auth)

40501 A 10,000 g PHOTOMULTIPLIER. Goodrich, G. W.; Love, J. L. (Bendix Research Labs., Southfield, Mich.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 190-4(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

An extremely small photomultiplier tube capable of withstanding shock accelerations in excess of 10,000 g's has been developed. The tube is composed of (1) a multi-alkali photocathode deposited on an end-on window that is transfer sealed to the tube body, (2) an electron multiplier composed of 1008 continuous dynode electron multipliers, (3) a cylindrical tube body especially designed for hard mounting, and (4) a ruggedized anode. Only four electrical connections are needed to operate the tube. The tube weighs less than 13 grams and occupies a volume of less than a cubic inch. Tube operation under dc and wide bandwidth conditions are discussed. In addition, performance characteristics are discussed. These characteristics include gain, power dissipation, dark current, and output current. Potential uses for the tube are also described which include (1) scintillation sensing, (2) laser pulse detection, (3) space instrumentation applications, and (4) spatial as well as time resolution potential. (auth)

40502 HIGH-TEMPERATURE PERFORMANCE OF METAL-CERAMIC PHOTOMULTIPLIERS. Matheson, R. M.; Helvy, F. A. (Radio Corp. of America, Lancaster, Pa.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 195-7(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

The feasibility of making metal-ceramic photomultipliers capable of surviving and operating at temperatures up to 175°C has been demonstrated. These tubes use the CsK_2Sb photocathode and have typical quantum efficiencies of 25 to 30 per cent. Results indicate that CsK_2Sb is an extremely stable photocathode when a suitable environment can be provided. Tube performance characteristics have been measured over the temperature range from room temperature to +175°C. The variation of sensitivity (pulse height) and pulse-height resolution as a function of temperature has been determined. The temperature dependence of dark current and noise has also been evaluated. The data indicate that tubes of this type are suitable for many scintillation counting applications throughout this temperature range. (auth)

40503 IMAGE INTENSIFIER: TELEVISION SYSTEM FOR THE DIRECT RECORDING OF X-RAY DIFFRACTION PATTERNS. Arndt, U. W.; Ambrose, B. K. (MRC Lab. of Molecular Biology, Cambridge, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 92-4(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

A system has been designed which will permit the scanning of x ray diffraction patterns and the direct reading in of the digitized intensities of x-ray diffraction spots into a computer. The system makes use of two image intensifiers and a slow-scan television camera in tandem. (auth)

40504 QUANTITATIVE STUDIES OF WEAK LIGHT SOURCES IN BIOLOGICAL SYSTEMS BY MEANS OF AN IMAGE INTENSIFIER. Reynolds, George T. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 58-66(June 1968). (NYO-3407-7).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Experiments are described in which an image brightness intensifier microscope system was used to study bioluminescence and to provide data on temporal and spatial distribution of light output in Noctiluca miliaris and Gonyaulax polyedra. Other experiments are described in which the location of weak radioactive tracers was possible in short exposure times; thin overlying scintillators provided the necessary light. System requirements were discussed for the extension of this technique to x-ray studies and fluorescence microscopy. (B.S.L.)

40505 MASS SPECTROMETRY IN SCIENCE AND TECHNOLOGY. White, F. A. New York, John Wiley and Sons, Inc., 1968. 367p.

After a brief historical review of the development of mass spectrometers, the various designs, operation, and applications are discussed. Topics include types of mass spectrometers, methods of ion production, detection of ion beams, nuclear and reactor physics, electrophysics, semiconductor devices by ion-beam implantation, materials research, physics and chemistry of surfaces, space sciences, nuclear geology and isotope cosmology, ecology and environmental science, chemistry by mass spectrometry, and applications in biology and medicine. (B.G.D.)

40506 DOUBLE INLET SYSTEM WITH VISCOUS GAS INLET CURRENT FOR THE USE OF 2 ML GLASS AMPOULES AS THE SAMPLE CONTAINERS. Bigl, F. (Institut fuer Stabile Isotope, Leipzig. Forschungsgemeinschaft, Berlin). Isotopenpraxis, 4: 35-6(Jan. 1968). (In German).

For precision mass spectrometric isotope analysis on gases, the viscous gas current through a capillary is often used. The use of a double inlet system which combines the ampoule destruction device with a storage bin avoids the principal disadvantages of this method. The design and construction of such a double inlet system is described. (J.S.R.)

40507 FIZICHESKAYA ELEKTRONIKA. VYPUSK 3. (Physical Electronics, Volume 3). Chistyakov, P. N. Moscow, Atomizdat, 1966. 92p.

Eleven articles are included on electronic devices. The papers deal with such topics as the magnitude of normal cathode drop potentials in a glow discharge as a function of various factors (argon, neon, and xenon properties, cathode material and shape, and gas pressure), the resolving power of a two-cascade mass analyzer, the design and performance of energy–mass analyzers for pulsed ion beams, triple-focusing mass spectrometers, the work function of metals in inert gases, electrical stability in the vacuum gap of a high-current glow discharge, equations for electrical discharge coefficient in gases, a memory device for auto-

matic discharge volume calculations, and trajectograph for automatic construction of charged-particle trajectories in electrostatic fields, considering the beam spatial charge. (R.V.J.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 40400.

40508 (BNWL-SA-1857) FFTF COOLANT THERMOCOUPLE DEVELOPMENT. Huck, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 14, 1968. Contract AT-(45-1)-1830. 15p. (CONF-680526-1). Dep. CFSTI.

From ERA/ISA Symposium, Seattle, Wash.

A group of twenty-four thermocouples was exposed to a fast neutron fluence of approximately 2.7×10^{21} as part of a program to develop sodium coolant thermocouples for the Fast Flux Test Facility (FFTF). Chromel/Alumel is the most promising candidate thermocouple based on a negligible amount of decalibration and other thermal neutron reactor effects on this type of thermocouple. Chromel/Alumel, Geminol-P/Geminol-N, platinum/10% rhodium-platinum, tungsten/26% rhenium-tungsten, and 5% rhenium-tungsten/26% rhenium-tungsten thermocouples were subjected to a series of laboratory materials verification tests, response time tests, and emf calibration runs. The tests are being repeated after EBR-II fast neutron reactor irradiation to determine the extent of transmutation, or other property changes which would affect their performance in the FFTF. Although these initial thermocouple irradiations were run primarily for the purpose of developing measurement and handling techniques, much useful information is being obtained, which is being used in irradiation testing of additional base metal thermocouples. (auth)

40509 (N-68-13147) RADIATION EFFECTS ON COMPOSITE STRUCTURES. (Lockheed-Georgia Co., Marietta). Apr. 1966. Contract NAS8-20206. 76p. (NASA-CR-91345; ER-8582). CFSTI.

The electrical breakdown of Mylar micrometeoroid detectors was studied under simulated space conditions to determine the amplitude range of trapped electron breakdown pulses, a method of discriminating them from micrometeoroid produced pulses, and the temperature dependence of electron breakdown pulses. Pegasus panels, used as test specimens, were placed in a controlled temperature heat sink, with the electron source mounted inside the heat sink volume and parallel to the panels. The entire assembly was located in a large vacuum chamber held at approximately 10^{-6} torr. Temperature was varied and controlled from ambient to -90°F. Principal test results indicate pulses were of both polarities with respect to the bias voltage of the panel; pulse rise time was on the order of microseconds; amplitude and polarity of breakdown pulses were apparently independent of bias or load resistance; breakdown rate varied approximately inversely with temperature essentially vanishing at room temperature; and the spectrum of breakdown amplitudes decayed rapidly with amplitude, with no pulse observed greater than 2.7 volts. (STAR)

40510 (N-68-20944) EFFECTS OF SOLAR PROTON FLARES ON THE POWER OUTPUT OF SOLAR CELLS HAVING VARIOUS CONFIGURATIONS. Berman, Paul (Jet Propulsion Lab., Pasadena, Calif.). Feb. 15, 1968. Contract NAS7-100. 18p. (NASA-CR-93922; JPL-TR-32-1251). CFSTI.

In designing a photovoltaic power system for deep space missions it is necessary to allow for degradation of the electrical output caused by exposure to solar proton flares. A technique for predicting the degradation of solar-cell power output for P/N and N/P silicon solar cells for two solar flare models is presented. The results of an experiment conducted to test the validity of the technique are also presented. The proton energies of 36, 100, and 137 MeV were used in the experiment. For protons of these energy levels, at a fluence of 2×10^{10} protons/cm^2, the only measurable electrical degradation occurred in the solar cell and not in the coverglass or coverglass adhesive. In general, the predictions were in reasonable agreement with the experimentally observed electrical degradations, but were pessimistic by approximately 6 to 9 and 3 to 6% for P/N and N/P cells, respectively. Some possible explanations for these discrepancies are given. (auth) (STAR)

40511 (SC-CR-68-3659) AN ANALYSIS OF THE EFFECTS OF IONIZING RADIATION IN ONE-DIMENSIONAL METAL-OXIDE-SEMICONDUCTOR STRUCTURES. Final Report EE-153. Gwyn, C. W. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). May 1968. Contracts AT(29-1)-789; UNM-290-861. 235p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Previous investigations of the radiation effects in Metal-Oxide-Semiconductor (MOS) devices have shown that ionizing radiation produces a trapped space charge in the oxide which causes a shift in the electrical characteristics of the device. Several models have been proposed to explain the observed change in the MOS device characteristics as a function of nuclear radiation exposure. Although these models have qualitatively explained the change in device characteristics, they have not adequately explained the physical processes producing the charge buildup nor have they considered the detailed conduction and charge trapping processes which exist in the various regions of an MOS structure. This analysis of the MOS structure was undertaken to summarize and indicate the deficiencies which exist in the previous models, to investigate the charge trapping characteristics of the SiO_2 layer, and to calculate the transient characteristics of an MOS structure. A study of the properties of the SiO_2 layer has been performed wherein the applicability of using an energy band model for amorphous SiO_2 has been qualitatively investigated. The charge trapping characteristics of the oxide as a function of the radiation exposure have been summarized and the similarities between the ionizing radiation effects in fused silica, quartz, and SiO_2 are noted. A broken bond model for hole trapping in the oxide after irradiation is proposed. This model which is based upon the close similarity between the radiation effects in the three glass forms has an advantage over other charge trapping models inasmuch as the trapping in relatively impurity-free SiO_2 can be explained. The application of such a model offers plausible explanations for the buildup of the radiation-induced charge in the oxide and subsequent annealing of the charge as a function of temperature and exposure to ultraviolet radiation. In addition, possible radiation hardening techniques for preventing the charge buildup in the oxide are suggested; these are based upon the concepts presented in the discussion of the model. Numerical calculations are presented for the characteristics of an unirradiated one-dimensional MOS structure wherein capacitance, surface field, surface potential, and surface charge density in the silicon are determined for non-equilibrium conditions. These calculations are performed for non-uniform impurity doping profiles in the silicon and for various surface and bulk charge trapping distributions. The conduction characteristics of the oxide layer during and after irradiation are illustrated by both analytical and numerical solutions for the charge and electric field distributions as a function of time. As a result of the change in the electric field distribution produced by the relatively immobile positive charge, it is shown that the mobile charge can remain in the oxide for much longer time intervals than the normal transit time for carriers across the oxide layer. (auth)

40512 EFFECTS OF DAMAGE BY 0.8 MeV TO 5.0 MeV PROTONS IN SILICON SURFACE-BARRIER DETECTORS. Coleman, J. A. (National Bureau of Standards, Washington, D. C.); Love, D. P.; Trainor, J. H.; Williams, D. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 3, 363-72(June 1968).

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C. See CONF-680207.

Changes in the performance of silicon surface-barrier detectors after irradiation with protons at energies between 0.80 MeV and 5.00 MeV have been investigated for fluences up to 10^{17} protons cm^{-2}. Irradiations of the front, surface-barrier contacts and the rear, ohmic contacts of these transmission detectors were performed. In general, the detector current and noise increased with fluence. When the rear, ohmic contact was irradiated with protons which stopped within the detector, the changes in the current and noise after irradiation were several orders of magnitude smaller than after a similar irradiation of the front contact. For protons with energies greater than about 1 MeV, the detector capacitance decreased at low reverse biases and increased at high biases with increasing fluence. The results indicate that a significant reduction in the increase of detector current and noise can be obtained if the density of radiation-produced defects in the region of the junction is minimized. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 40122, 40123, 40126, 40615, 40671, 40685, 40703, 40768, 40771, 40792, 40795, 40805, 40821, 40824, 40827, 40830, 40831, 40833, 40834, 40853, 40909, 40914, 40926, 40943, 40944, 40951, 40952, 40959, 40965, 40969, and 40989.

40513 (BNWL-SA-1915) UPTAKE, DISTRIBUTION, AND EXCRETION OF PROMETHIUM IN HUMANS AND THE EFFECT OF DTPA ON THESE PARAMETERS. Palmer, H. E.; Crook, G. H.; Nelson, I. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 6, 1968. Contract AT(45-1)-1830. 12p. (CONF-680607-5). Dep. CFSTI.

From 13th Annual Health Physics Society Meeting, Denver, Colo.

In order to form a basis for radiation exposure limits and to determine the dose from accidental exposure, the uptake, retention, distribution, and excretion of ^{143}Pm was studied in human volunteers. Whole-body counting techniques and urinary and fecal measurements were used. The uptake in the liver following intravenous administration was very rapid with most of the liver fraction arriving there within 90 seconds. The 50 to 60% of the ^{143}Pm that did not go to the liver appeared to remain in the blood for a short time and gradually deposit in the bones. The excretion of ^{143}Pm following intravenous injection was via both urine and feces. The rate of fecal excretion did not decrease as rapidly as the urinary excretion rate. Excretion analyses of orally ingested ^{143}Pm showed that essentially none of the material was absorbed by the body and all of it was excreted in the feces. Results indicated that the biological half-life of ^{143}Pm in the total body was greater than 1000 days. The effect of DTPA on the excretion and retention was studied and it was observed that DTPA was very effective in significantly reducing the body content of promethium when administered within about an hour after internal deposition. If the DTPA was given 5 or more hours later, the body burden decreased by only 50% or less. (B.S.L.)

40514 (CONF-670965-2) ZWEI FAELLE VON INNERER KONTAMINATION MIT ^{231}Pa UND DEREN BEHANDLUNG MIT DTPA. (Two Cases of Internal Contamination with ^{231}Pa and Their Treatment with DTPA). Giubileo, M. (European Atomic Energy Community). [1960]. 8p. (In German).

From 13th Conference on Sanitary Physics, Ispra, Italy.

A chemical laboratory, in which eight persons were exposed to contact with samples emitting β and γ radioactivity, was contaminated with ^{231}Pa in the form of insoluble powder. After 2 weeks, the incident was revealed as the cause of α radioactivity in the air: the maximum value of surface contamination (measured with the smear test) was 10^{-6} μCi/cm^2; traces of activity were found in the nasal mucous of four persons and in six urine samples. The two patients in which the α contamination exceeded 0.05 dpm/l of urine were treated with DTPA. The complexing agent caused an increase in urinary excretion with sleepiness as a collateral effect. Tests showed that the internal contamination in the two patients did not exceed 10% of the maximum permissible level. The precautions put into effect to prevent a recurrence of the incident are described. (tr-auth)

40515 (NYO-1822-25) CALCIUM AND STRONTIUM METABOLISM. V. THE EFFECT OF SULFADIAZINE AND OTHER GROWTH AND METABOLIC INHIBITORS. Ballentine, Robert; Burford, Dorothy D. (Johns Hopkins Univ., Baltimore, Md. McCollum-Pratt Inst.). Dec. 15, 1966. Contract AT(30-1)-1822. 45p. Dep. CFSTI.

The interrelationships between cellular metabolism and the accumulation of calcium and strontium during growth by Tetrahymena pyriformis were investigated by the use of antimetabolites and metabolic inhibitors. Inhibitors of nucleic acid metabolism (benzimidazole, thiouracil, isonicotinic acid hydrazide), of antimetabolites of amino acids (thenylalanine, benzimidazole), and of anti-cofactors of group transfer systems (desthiobiotin, pantoyltaurine, oxythiamine, pyrithiamine) are all without effect upon accumulation of strontium, as is the anti-acetylcholine esterase agent, eserine. Some uncouplers of oxidative phosphorylation are ineffective inhibitors of strontium accumulation (namely dinitrophenol, thyroxine, and thiouracil), but one, dicoumarol, is an effective inhibitor. The reasons for this difference in activity are discussed. The most effective inhibitors of strontium accumulation are those compounds that alter the electron transport chain at the NAD–NADH$_2$ and flavoprotein steps. This would be anticipated from the previously observed effectiveness of a nicotinamide or riboflavin deficiency in altering calcium and strontium metabolism. Sulfadiazine preferentially inhibits strontium accumulation as contrasted to calcium accumulation. This preferential action was studied in terms of the relationship between inhibitor concentration and accumulation pattern, the influence on the distribution of calcium and strontium in complexes in subcellular particles, and the distribution of exchangeably complexed forms. (auth)

40516 (ORO-657, pp 65-92) SOIL CHEMISTRY. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

This research program is concerned with those properties of a clay system that control ion exchange kinetics and ion exchange equilibrium. This relates not only to the availability of cations to the plant, but also to those fission products in the soil in cation forms. It was found that the hydration status of the cation influences both the kinetics and equilibrium behavior of the clay-cation interaction, thus the predictions regarding the use of ion exchangers were based on the hydrated radii rather than on the crystal radii. Selection of the proper exchange medium will also influence the status of the radii of the cations depending on its weak or strong acid properties. Current research centers around the study of the selectivity sequence for the alkali metal cations on Kaolinite and Wyoming Bentonite clays at different pH levels. Progress is also reported in the area of diffusion kinetics in non-ideal systems. Analysis of the kinetics involved will result in a better understanding of the movement of fission products through complex soil systems. Also reported are data from research on specific reactions affecting cation availability in clay minerals. The specific reactions in this case are fixation reactions. Understanding of the kinetics of these reactions is important because two essential plant nutrients, K^+ and NH_4^+, and the fission product, Cs^+, are among the cations most susceptible to fixation. Results to date indicate that once Cs^+ is sorbed on the surface of vermiculite it is effectively fixed and is thus not isotopically exchangeable with other Cs. What effects this will have on the exchangeability of Cs against other cations remains to be seen. (E.R.B.)

40517 (ORO-1643-89) STUDIES IN IODINE METABOLISM. Progress Report, July 1967–July 1968. Van Middlesworth, L. (Tennessee Univ., Memphis. Dept. of Physiology and Biophysics). Contract AT(40-1)-1643. 37p. Dep. CFSTI.

Summaries are presented of research on iodine metabolism in hypophysectomized rats; thyroidal iodine that is slowly released from the thyroid gland; synthesis of iodinated adenosine monophosphate; autoradiography of thyroid glands; synthesis of triiodothyronine in thyroids of rats and hamsters; influence of thiocyanate on binding of thyroxin to human plasma albumin; use of ultracentrifugation to fractionate proteins from extremely hyperplastic thyroid glands; weight loss in patients with thyroid disease; and fallout iodine content of animal thyroids from different parts of the world. A list of the items published during the research year is also presented. (B.S.L.)

40518 (RT/BIO-(68)3) RICERCHE SUL DIFFERENZIAMENTO DI CELLULE IMMUNOLOGICAMENTE COMPETENTI. Relazione Annuale, 1966. (Research on Differentiation of Immunological Competence of Cells. Annual Report, 1966). Doria, G. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). June 8, 1967. 22p. (In Italian). Dep.

A study of the role of the thymus in the differentiation of immunologically competent cells established that thymus-dependent cells of splenic origin can acquire thymus independence if they are cultivated in vivo for a month in the presence of thymus. The thymus-independent cells are located in the lymph nodes and the spleen, but not in the marrow. These data, analogous to that observed for cells of marrow origin, suggest the hypothesis that the thymus promotes the differentiation of potentially competent cells in the absence of antigen stimulation. The number of immunologically competent cells in the spleen of rats lethally irradiated and restored with syngenic or allogenic bone marrow at various times after the grafting was determined. It was found that the immunological efficiency of syngenic graphs depends initially on the repopulation degree of the spleen and then on the repopulation of other lymphatic areas. In allogenic grafts the immunization system of the spleen remains the principal tissue of immunization response. Research was initiated on the role of RNA in the production of antibodies. A hybridization technique for the identification of specific RNA for the synthesis of immunoglobulin was developed. (tr-auth)

40519 ACTION OF SUGARS TREATED WITH ^{60}Co γ RAYS ON THE DEVELOPMENT OF SOME VEGETABLE TISSUES CULTIVATED IN VITRO. Schaeverbeke, Janine; Jonard, Robert; Manant, Pierre (Laboratoire de Biologie Cellulaire, Paris). Compt. Rend., Ser. D, 266: 830-2(Feb. 19, 1968). (In French).

The γ irradiation (^{60}Co) of sugars (fructose, glucose, maltose, sucrose, and xylose) in the dry state reduced their ability to maintain the in vitro proliferation of vegetable tissues (Topinambour ayant, Jerusalem artichoke). When the sugars were irradiated in aqueous solution, they stimulated formation and elongation of roots. It was concluded that these modifications in growth resulted from chemical alterations. (tr-auth)

40520 THE ABSORPTION OF STRONTIUM BY CHARA FRAGILIS DESVAUX. Walter-Levy, Leone; Strauss, Rene (Faculte des Sciences, Caen, France. Faculte des Sciences, Dijon, France). Compt. Rend., Ser. D, 266: 1486-9(Apr. 1, 1968). (In French).

The absorption by Chara fragilis Desvaux of strontium introduced into the culture medium was studied by examination of the dry thallus by radiocrystallography and the determination of the alkaline earths in the plant ashes. The chemical analysis showed in all cases an absorption of Sr by the thallus. The Sr, which can attain a concentration of 24% of the dry matter, increased as a function of the concentration of the element in the external medium. The percentage of Sr was higher in the young axes than in the trunk plant. The sum of the Sr and Ca ions had little variation. The radiograms show the presence of calcite and of two solid solutions of calcium and strontium carbonate, the first rhombohedric of the calcite type and the second orthorhombic of the aragonite and strontianite type. The data showed that in Sr-enriched medium, Chara fragilis absorbed Sr principally in the form of mixed crystals belonging to the orthorhombic system. (J.S.R.)

40521 METABOLISM AND TOXICITY OF THERAPEUTIC CHELATING AGENTS. FIRST REPORT. COMPARATIVE STUDIES ON THE EXTRACTION OF EDTA AND DTPA IN THE URINE OF RATS. Harmuth-Hoene, Anna-Elisabeth (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie, 134: 110-22(Sept. 1967). (In German).

The urinary excretion of ^{65}Zn and ^{14}C-labeled chelates of ethylenediaminetetraacetic acid (EDTA) and diethylenetriaminepentaacetic acid (DTPA) was studied in rats. It was shown that the observed retention of ^{65}Zn was due to isotopic exchange with endogenous Zn; no genuine splitting-off took place. In addition, Zn-DTPA was capable of mobilizing endogenous Zn. The excretion rates of Ca- and Zn-chelates rose with increasing dosage. (auth)

40522 EFFECT OF CYANOFERRATES ON THE EXCRETION OF RADIOCESIUM BY RATS AND GOATS. Havlicek, Frantisek; Kleisner, Ivan; Dvorak, Pavel; Pospisil, Jan (Univ., Prague). Strahlentherapie, 134: 123-9(Sept. 1967). (In German).

Oral administration of cyanoferrates (II) enhanced the fecal excretion of internally deposited ^{134}Cs in rats and, thus, led to a diminution of its biological half-time. The effectiveness of the different cyanoferrates increased in the order: $K < Ca \sim Co^{II} \sim Zn < Fe^{III}$. In goats, however, potassium cyanoferrate was more effective than ferricyanoferrate. The meaning of this discrepancy was discussed. (auth)

40523 STUDIES ON BIOLOGICAL RADIATION PROTECTION. 79TH REPORT. ACTIVITY OF SERINE-SULFHYDRASE, CYSTEINEDESULFHYDRASE AND CYSTATHIONASE IN THE MOUSE LIVER AFTER IN VIVO RADIATION. Waldschmidt, Marianne; Herzig, Benno (Univ., Freiburg i. B.). Strahlentherapie, 134: 92-101(Sept. 1967). (In German).

The activities of serine-sulfhydrase, cysteine-desulfhydrase and cystathionase were measured in the liver of mice 12 hours to 12 days after whole body irradiation with 690 R. The activity of the serine-sulfhydrase was decreased significantly to about 50% of the control value four to six days after irradiation; however, it was significantly increased after 24 hours of food deprivation. The activities of cysteine-desulfhydrase and cystathionase were significantly decreased to about 80% of the control value seven to 12 days after irradiation. The activities of cysteine-desulfhydrase and cystathionase decreased significantly seven to 11 days after administration of 5-hydroxytryptamine and 14 to 25 days after administration of trianisylchlorethylene. Additional irradiation did not result in a further decrease. The results pertaining to the similarity between radiation sickness and vitamin-B_6-deficiency as well as the mechanism of the radiation protective substances were discussed. (auth)

40524 EFFECTS OF IONIZING RADIATION ON PYROPHOSPHATE UPTAKE AND PYROPHOSPHATASE ACTIVITY IN MYCOBACTERIA. Meissner, Johannes; Schanz, Wolf (Borstel Research Inst., Ger.). Strahlentherapie, 134: 130-7(Sept. 1967). (In German).

Results obtained with Mycobacterium tuberculosis strain BCG 14 in Sauton-medium with the addition of ^{32}P-pyrophosphate are reported. The uptake of the offered pyrophosphate into ATP and the nucleotide fraction was favored to the orthophosphate uptake. The pyrophosphatase activity could be observed independently from the conditions of the bacterial growth in the enzyme-containing medium after filtration of the grown bacteria and with addition of radioactive labeled enzyme substrate. Radiation influence by means of an addition of carrier-free $H_2{}^{35}SO_4$ resulted in an inactivation dose of about 10^5 rad, using the conditions chosen. The use of this experimental model for other depolymerases as well as for radiobiological investigations using various types of radiation was discussed. (auth)

40525 STUDIES ON THE USE OF LEUKOCYTE CONCENTRATES FOR RADIOBIOLOGICAL EXPERIMENTS ON MAST CELLS. Baudach, Helmut; Magdon, Erwin; Rotte, Karl-Heinz; Ziegenbein, Renate (Robert Roessle Clinic, Berlin). Strahlentherapie, 134: 66-79(Sept. 1967). (In German).

A modified saponin-hemolysis was described that produced leukocyte concentrates that could be evaluated quantitatively. This method was used for studying the radiation reaction of mastocytes in the blood of humans and rats. Cytological changes were observed after x irradiation. They were considered to be a sign of increased production and release of heparin and histamine. (auth)

40526 SIMPLE AND RAPID DETERMINATION OF MERCURY IN URINE AND TISSUES BY ISOTOPE EXCHANGE. Clarkson, T. W.; Greenwood, M. R. (Univ. of Rochester, New York). Talanta, 15: 547-55(June 1968).

The method described eliminates oxidation of organic material. Tracer quantities of ^{203}Hg are added to the sample and equilibrated with the stable mercury. ^{200}Hg vapor in nitrogen is passed through the sample in the presence of cysteine and at pH 7.4, and exchanges with the ^{203}Hg. The vapor is collected in a tube of activated Hopcalite placed in a gamma-counter. The increasing activity is recorded, and the half-time of exchange is directly proportional to the mercury concentration in the sample. The method is best suited for urine samples containing more than 10 μg Hg/l. (auth) (UK)

40527 HISTOENZYMOLOGICAL NOTE ON THE α-HYDROXYBUTYRO-DESHYDROGENASE ACTIVITY IN THE KIDNEY OF MICE DURING EXPERIMENTAL INTOXICATION WITH URANYL NITRATE. Turchini, J. P.; Bastide, P. Compt. Rend. Soc. Biol., 161: 1986-9(1967). (In French).

An adaptation of the Rosalki technique was used for the histoenzymological study of α-hydroxybutyrate-dehydrogenase activities. In the mouse kidney, these activities were in the cortical region of the kidney on the convoluted No. 1 and No. 2 tubes; the activity was notably reduced after experimental intoxication with uranyl nitrate. (tr-auth)

40528 EFFECT OF DEUTERIUM OXIDE ON THE CULTURING OF PENICILLIUM JANCZEWSKII. II. ISOLATION OF FULLY DEUTERATED GRISEOFULVIN. Nona, D. A.; Blake, M. I.; Crespi, H. L.; Katz, J. J. (Univ. of Illinois, Chicago). J. Pharm. Sci., 57: 975-9(June 1968).

Fully deuterated griseofulvin was isolated in pure form from Penicillium janczewskii grown in a completely deuterated medium. Direct fermentation and a replacement culture technique were used. The isolated antibiotic was purified by thin-layer chromatography and characterized by ultraviolet, infrared, and nuclear magnetic resonance spectra. The extent of incorporation of deuterium during biosynthesis at the various proton sites in the molecule was determined. (auth)

40529 CONTAMINATION OF POTATO TUBERS WITH ^{85}Sr AND ^{137}Cs BY INJECTION AND TRANSPORTATION OF THE ACTIVITY IN OTHER PARTS OF THE TUBER. Paulus, K. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atompraxis, 14: 123-6(Mar. 1968). (In German).

It is possible to contaminate artificially potato tubers with radionuclides injected into the center. ^{85}Sr and ^{137}Cs are both transported outwards, dependent on the time of storage. In this context the term transported includes all transport processes, such as diffusion and active transport. A distribution in the tuber, similar to that of natural contamination cannot be realized. In the case of ^{137}Cs, however, an almost homogeneous distribution of the activity is reached after about 10 days. ^{85}Sr is less mobile, and the experimental situation is less favorable. A total contamination is possible, but there are considerable differences regarding the activity contents of the different parts of the potato tuber. (auth)

40530 INHIBITION OF THE GRAFT-VERSUS-HOST REACTION BY PRETREATMENT OF DONORS WITH VARIOUS ANTIGENS. Liacopoulos, P.; Merchant, B.; Harrell, B. E. (National Inst. of Allergy and Infectious Diseases, Bethesda, Md.). Transplantation, 5: 1423-35(Nov. 1967).

The effect of pretreating mice with diverse antigens on the capacity of their spleen cells to produce fatal graft-versus-host (GVH) disease across an H-2 histocompatibility barrier was investigated. The mortality rate of midlethally x irradiated recipients given spleen cells from untreated donors was a linear function of the number of cells transferred. Equal numbers of spleen cells from antigen-treated donors consistently showed a reduction in their capacity to produce fatal GVH disease. Microbial antigens were ordinarily more potent than soluble protein antigens in producing this effect. Furthermore, intensive daily antigen pretreatment generally caused greater impairment of spleen cell GVH reactivity than pretreatment with lower doses of antigen. Relative dilution of GVH competent cells as a result of splenic hyperplasia in antigen-treated donors accounted for only a portion of the observed effect. The data indicate that when donor cells are actively engaged in processing nontransplantation antigens, there occurs a significant interference in their GVH reactivity. (auth)

40531 CONGENIC MOUSE STRAINS WITH DIFFERENT IMMUNOGLOBULIN ALLOTYPES. I. BREEDING SCHEME, HISTOCOMPATIBILITY TESTS, AND KINETICS OF γG_{2a}-GLOBULIN PRODUCTION BY TRANSFERRED CELLS FOR C3H.SW AND ITS CONGENIC PARTNER CWB/5. Klein, Jan; Herzenberg, Leonard A. (Stanford Univ., Palo Alto, Calif.). Transplantation, 5: 1484-95(Nov. 1967).

The production of congenic lines of mice differing at immunoglobulin loci is described. After five backcross generations a pair of lines was developed which, although skin-compatible, still have barriers for transferred spleen cells, as followed by quantitating donor type γ-globulins in the recipients' sera. The barriers are x-radiation-sensitive and can be overcome by large numbers of transferred cells. One barrier, which can be largely overcome by 300 R whole-body x irradiation, is described as lack of biological space. The second barrier may be residual histoincompatibility. Spleen, bone marrow, and fetal liver, but not thymus cells produced γ-globulins for many weeks after injection into 600 R irradiated congenic recipients. As donor type levels increased, host type decreased in some animals to very low levels. The usefulness of the congenic strains being produced for studies of cell immunological potential, regulation, and function is discussed. (auth)

40532 CHARACTERISTICS OF THE CELLULAR RESPONSE IN PRETREATED RECIPIENTS EXHIBITING ENHANCED TUMOR GROWTH. Chantler, S. M. (Guy's Hospital Medical School, London). Transplantation, 5: 1400-8(Nov. 1967).

Mice pretreated with γ irradiated benzpyrene-induced ascites sarcoma (B.P.8) cells and later challenged intraperitoneally with viable B.P.8 grafts first passed through a phase characterized by accelerated destruction or immunity followed by one in which graft enhancement occurred. The type of response observed was dependent on the interval between pretreatment and challenge. Pretreatment schedules calculated to provoke enhancement of subsequently grafted tissue did not cause quantitative or qualitative deficiencies in the host cellular response. Ascitic fluid containing antibody from individuals exhibiting enhancement was found to interfere with the capacity of host cells, obtained from the same ascites, to effect adoptive immunization. (auth)

40533 INACTIVATION OF ALDOLASE BY X RAYS. Gorin, G.; Quintiliani, M. (Oklahoma State Univ., Stillwater). Experientia, 24: 440-1(May 15, 1968).

Measurements were made of the x-radioinduced inactivation yield of rabbit muscle aldolase in 0.05M phosphate buffer, in 0.01M buffer, and in doubly-distilled water. The dose modifying effects of various added radioprotective substances were also tested. Differences in the solvent had practically no effect on the activation yield. It was concluded that many primary ionizations occurred in the solvent per molecule of aldolase inactivated and that inactivation was caused by reactions with H, OH, and OOH radicals radioinduced in water in the solutions. The low inactivation yield indicated that only a small fraction of the radicals produced were effective in causing inactivation. The addition of cysteamine or cysteine to the solution had a pronounced protective effect against radioinduced inactivation of the enzyme but the addition of sodium iodide, iodoacetic acid, 3-iodopropionic acid, or the radiomimetic agent, ethyl methanesulfonate, had little effect on the radioinduced inactivation of aldolase. (C.H.)

40534 NORMAL IMMUNE RESPONSES OF BURSALESS CHICKENS TO A SECONDARY ANTIGENIC STIMULUS. Rose, M. Elaine; Orlans, Eva (Houghton Poultry Research Station, Huntingdon, Eng. Cambridge Univ., Eng.). Nature (London), 217: 231-5(Jan. 20, 1968).

Hormonal bursectomy, inhibition of the development of the bursa by testosterone, was found to be more effective than surgical bursectomy coupled with irradiation in depressing the primary response to soluble antigens. None of the treated birds was agammaglobulinaemic, and all formed some antibody. (auth) (UK)

40535 IN VIVO AND IN VITRO EFFECT OF ANTI-LYMPHOCYTIC IgG ON SENSITIZED SPLEEN CELLS. James, K. (Univ. of Edinburgh. Medical Research Council, Edinburgh). Nature (London), 217: 261-2(Jan. 20, 1968).

It was shown that treatment of a number of animals with species specific anti-lymphocytic antibody suppresses their primary immune response to a variety of antigens. Cell transfer experiments have also shown that non-sensitized lymphoid tissue from mice treated with anti-lymphocytic antibody can exhibit a reduced immunological potential when transferred to suitably prepared recipients. Furthermore, suppression of suspensions of sensitized mouse and rabbit lymphoid cells can also be achieved by incubating them in vitro with anti-lymphocytic antibody before transferring them to test recipients. In order to confirm and extend these previous cell transfer results, preliminary experiments were undertaken to determine the effect of anti-rat lumphocyte antibody treatment (in vivo and in vitro) on the humoral antibody producing potential of sensitized rat spleen cells on subsequent transfer to irradiated recipients. (auth) (UK)

40536 MECHANISMS IN EARLY AND LATE PHASES OF TOLERANCE INDUCED BY PARABIOSIS IN ADULT MICE. Nisbet, N. W. (Orthopaedic Hospital, Oswestry, Eng.). Nature (London), 217: 265-7(Jan. 20, 1968).

As part of the studies described, sensitization of CBAT 6T6 parental partners was studied by estimating the immunological potential of spleen cells from parabionts after various times in parabiosis in lethally irradiated (CBA × C3H)F_1 hybrids. It was argued that sensitized CBAT 6T6 parabiont cells would cause rapid death by severity of the graft-host reaction. Several experiments tended to show that reactive parental cells were sensitized in the hybrid partner in the early phase of parabiosis, and rendered tolerant in the later phase. Data are given for the potential of graded doses of parabiont spleen cells in restoring lethally irradiated F_1 hybrids, and for survival of irradiated F_1 hybrids restored with spleen cells from tolerant normal CBAT 6T6 and F_1 hybrid mice (also for cells from CBAT 6T6 parabionts). (UK)

40537 AN ANALYSIS OF THE INHIBITORY EFFECT OF CORYNEBACTERIUM PARVUM ON GRAFT-VERSUS-HOST DISEASE. Howard, J. G.; Biozzi, G.; Stiffel, C.; Mouton, D.; Liacopoulos, P. (Univ. of Edinburgh. Institut d'Immuno-Biologie, Paris). Transplantation, 5: 1510-24(Nov. 1967).

Graft-versus-host (GVH) disease, initiated by the injection of parental strain (C57BL) spleen cells into adult F_1 hybrid mice, was inhibited dramatically by pretreatment of the host with a suspension of killed Corynebacterium parvum. This protective effect was demonstrable in terms of both survival rates and phagocytic responses. By means of the T6 chromosome marker, it was found that proliferation of donor cells in the spleen was largely suppressed. Furthermore, antibody formation by adoptively transferred preimmunized C57BL spleen cells was depressed in C. parvum treated F_1 hybrid recipients. The inhibitory effect induced by C. parvum could be attributed neither to augmentation of an immune response against hypothetical parental strain antigens nor to lack of space for donor cells in the host due to gross proliferation of lymphoreticular tissues. Resistance to donor cells in C. parvum-treated F_1 hybrids could be overcome either by massive overloading with the donor cells or by 500 R whole-body x irradiation of the host. Evidence is discussed which suggests that C. parvum augments a preexisting low grade resistance to parental cells in the strain combinations used, which may be an expression of the phenomenon of allogenic inhibition. (auth)

40538 EFFECTS OF X IRRADIATION ON RIBONUCLEASES IN BLOOD PLASMA. Gresham, P. A.; Pover, W. F. R. (Univ. of Birmingham, Eng.). Experientia, 24: 444-5(May 15, 1968).

The effects of whole-body exposure of rats and guinea pigs to a dose of 700 R x radiation on the content of RNAase in the blood plasma were studied in an attempt to clarify the relation between tissue and plasma enzyme levels. Both acid and alkaline RNAase were found in plasma; 18 hr following irradiation the activity was noticeably increased. It was concluded that the changes in plasma enzyme levels were caused by increased synthesis of RNAase combined with release of the enzyme from damaged cells. (C.H.)

40539 PITUITARY CONTENT OF SOMATOTROPIN, GONADOTROPIN, AND THYROTROPIN IN RATS WITH STUNTED

LINEAR GROWTH FOLLOWING HEAD X-IRRADIATION. Mosier, H. David Jr.; Jansons, Regina A. (Univ. of Illinois, Chicago. Univ. of California, Irvine. College of Medicine, Los Angeles). Proc. Soc. Exp. Biol. Med., 128: 23-6(May 1968).

The injection of homogenates of the pituitaries of rats stunted by 600 R of x irradiation administered to the head and of nonirradiated controls into hypophysectomized immature female rats resulted in comparable responses in terms of tibial epiphyseal width, gonadal weight, and thyroidal ^{131}I uptake. An exception occurred in 121-day-old females in which the pituitary homogenate of the stunted animals produced about twice the gonadal weight in the assay animals as did those of controls. These findings combined with those of earlier experiments, suggest that the permanent stunting resulting from head x irradiation is not the result of hormonal deficit. (auth)

40540 EFFECT OF WHOLE-BODY GAMMA-IRRADIATION ON THE CONCENTRATION OF NUCLEAR HISTONES IN RAT THYMUS. Suhar, Alojz; Furlan, Miha (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Strahlentherapie, 134: 457-62 (Nov. 1967).

Measurements of nuclear histone fractions and of non-chromatin acid-soluble proteins were made in the thymus of the rat after whole-body gamma irradiation at 600 R. The concentration of total histones was decreased similarly as the thymic weight. Alterations in the distribution pattern of the three histone fractions, i.e., lysine-rich (f1), slightly lysine-rich (f2) and arginine-rich (f3) fraction, were observed early after irradiation: the concentration of histone f1 was considerably increased at 3 hrs, whereas neither f2 nor f3 fraction was significantly changed. All three histone fractions were markedly depressed 24 hrs after irradiation. A decrease in the contents of cytoplasmic acid-soluble proteins was evident 3 hrs following irradiation, and a simultaneous rise in the concentration of acid-soluble proteins was demonstrated in the nuclear "soluble fraction." (auth)

40541 ELECTRON MICROSCOPIC STUDY OF ULTRAVIOLET IRRADIATION LOCALIZED ON THE NUCLEUS, NUCLEOLUS, AND CYTOPLASM. Moreno, Giuliana. Compt. Rend. Soc. Biol., 161: 1864-6(1967). (In French).

KB cells in culture were examined immediately after uv irradiation or after being returned to culture at variable times. The irradiation of the nucleus in whole or in part caused the appearance of small accumulations of chromatin distributed throughout the nucleus coupled with nucleoli and with the nuclear membrane. The irradiation of the nucleolus produced at first the dispersion of the perinuclear chromatin and then the disaggregation of the nucleolar material; moreover small accumulations of chromatin appeared throughout the nucleus as in nuclear irradiation. Irradiation of a portion of the cytoplasm caused the cavitation of mitochondria and the appearance of vacuoles, with the rest of the cell remaining normal. (tr-auth)

40542 EFFECTS OF VARIOUS DOSES AND TIME DISTRIBUTIONS OF RADIATION ON ABNORMAL MITOSES: STUDIES ON VICIA FABA. Kapp-Schwoerer, Hermann; Witzel, Lothar (Univ., Freiburg i. B.). Strahlentherapie, 134: 409-21(Nov. 1967). (In German).

The behavior of abnormal mitoses in Vicia faba are reported. These were observed for 14 days after gamma irradiation at doses of 600, 1200, and 2400 R as well as after different temporal distributions of these doses. The radiation effect upon cells that had already begun mitosis (primary effect) did not differ from the radiation effect upon the interphase nuclei (secondary effect). Moreover, the extent of radiation damage could not be determined from the frequency of abnormal mitoses. However, in the case of the same total dose, there was a distinct displacement of the percent distribution of abnormal mitoses that depended upon the dose rate. (auth)

40543 EFFECTS OF GAMMA IRRADIATION ON SOIL AGGREGATE STABILITY. Griffiths, Ellis; Burns, R. G. (Univ. Coll. of Wales, Aberystwyth, Eng.). Plant Soil, 28: 167-72(Feb. 1968).

Irradiation of polysaccharides produces degradation, and reduction of the chain length of microbial polysaccharides reduces their capacity to aggregate soils. It seemed possible therefore that irradiation might reduce aggregation in soils where this is caused by microbial polysaccharides. To investigate this possibility a study was made of the effect of irradiation on natural and synthetic (polysaccharide-amended) aggregates from various soils. The polysaccharide used was isolated from cultures of the soil yeast Lipomyces starkeyi, and incorporated in the aggregates at a concentration of 0.5%. Samples of the natural and synthetic aggregates and of the purified polysaccharide were γ-irradiated at a dose of 2.5 Mrad. No significant effect of irradiation was seen on either the natural aggregates or the synthetic aggregates that did not contain polysaccharide. Synthetic aggregates containing 0.5% polysaccharide were more stable than those without, and irradiation significantly reduced their stability. However, aggregates from the four soils were not affected equally; two soils (one originally the most stable) showed the greatest reduction in stability. Soils whose polysaccharide-treated aggregates responded least to irradiation had the highest clay content and vice versa. Clay in some way protects the polysaccharide from the damaging effects of irradiation. Aqueous solutions of the irradiated polysaccharide were much less viscous than the untreated material. Thus aggregation dependent upon microbial polysaccharide is sensitive to the effects of γ irradiation. Irradiation offers an analytical tool in assessing the extent to which aggregation in soils is dependent upon microbial polysaccharides. (BBB)

40544 AUTORADIOGRAPHIC DETECTION OF ^{24}Na IN SINGLE CELLS. Darzynkiewicz, Zbigniew; Komender, Janusz (Academy of Medicine, Warsaw). J. Histochem. Cytochem., 15: 605-7(Oct. 1967).

Autoradiographic detection of ^{24}Na ions offers a new approach to studies of membrane transport and related phenomena. Because of the extremely high mobility and solubility of ^{24}Na ions, the commonly employed autoradiographic techniques and some methods of dry autoradiography are inadequate. An autoradiographic method previously used for the localization of the soluble complex of ^{3}H-methotrexate and folate reductase in tissues was adapted for the detection of ^{24}Na ions in Ehrlich ascites tumor cells. The resolution of the autoradiographs appeared to be quite good for such a high-energy β particle emitter as ^{24}Na; this indicates that no significant diffusion of sodium isotope from cells into the surrounding emulsion occurred during exposure. The use of ^{22}Na in autoradiography may have more advantages because of its longer half-life and lower energy of β particles. (BBB)

40545 IMMUNOLOGICAL REACTIVITY AND BIOLOGICAL ACTIVITY OF IODINATED INSULIN. Brunfeldt, K.; Hansen, B. A.; Joergensen, K. R. (Steno Memorial Hospital, Gentofte, Denmark). Acta Endocrinol., 57: 307-29(1968).

Iodination of insulin with ^{128}I and ^{127}I and its effects on the properties of insulin are reported. Pig insulin substituted with 1.0 to 10.8 I/mole was made in preparative quantities and analyzed by elementary analysis, paper electrophoresis at pH 1.8, and uv spectroscopy. The preparations were tested for biological activity by intravenous injection into rabbits, by the mouse convulsion method, and by the effect on the ^{14}C-D-glucose turnover in isolated rat fat cells. The reactivity of the preparations with pig insulin antibodies from guinea pigs was tested by the double-antibody method in competition with ^{125}I-insulin iodinated to about 0.7 I/mole. The reactivity with insulin antibodies was also tested with ^{125}I-insulin having a higher degree of iodination, by simultaneous iodination with ^{127}I. At high degrees of iodination I also reacted with structures other than tyrosine in the insulin molecule. Weak noncovalent binding also seemed to occur. Iodination had a reducing effect, as a function of the number of iodine atoms per mole insulin, on the reactivity with antibodies as well as on the biological activity. (BBB)

40546 ERYTHROCYTE RUBIDIUM UPTAKE IN NORMAL AND CANCER PATIENTS. Vogel, John M.; Scott, Kenneth G. (Public Health Service Hospital, San Francisco). Arch. Intern. Med., 121: 76-80(Jan. 1968).

The rate of ^{86}Rb uptake by the erythrocyte was measured in 27 normal volunteers, 39 subjects with various nonmalignant lung diseases, and 38 subjects with biopsy-proven bronchogenic carcinoma of the lung. The lung disease category included patients with bronchiectasis, tuberculosis (active and inactive), coccidioidomycosis, emphysema, bronchitis, and asthma. The uptake of ^{86}Rb by the red cell during the first 4 min of incubation includes a fraction which is probably related to a surface phenomenon. The plasma ^{86}Rb radioactivity at 4 min was used as 100% activity and the erythrocyte uptake after 4 min was calculated. In 19 of the 38 bronchogenic carcinoma patients, aliquots of blood were treated by the addition of 100 μg of an antiserotonin and antihistamine drug, homochlorcyclizine (SA-97, N-p-chlorobenzhydryl-N'-methylhomopiperazine dihydrochloride) prior to performing the ^{86}Rb-uptake study, and the results were compared with the uptake in nontreated blood of the same 19 subjects. The rate of active uptake, as well as outward diffusion, was not statistically different between the normal and nonmalignant lung disease subjects, but were increased in the tumor-bearing subjects. These parameters returned to normal values when the histamine and serotonin antagonist was added to the incubation mixture. In four cases, these parameters returned to normal following resection of the lung tumor. (BBB)

40547 NEW METHODS OF COUNTING OF ^{14}C-LABELED HEMOGLOBIN AND HEMIN. Schwartz, Elias; Nathan, David G.

(Harvard Medical School, Boston). J. Lab. Clin. Med., 70: 841-8(Nov. 1967).

Methods for the rapid and efficient radioassay of ^{14}C-labeled hemoglobin and hemin are described. The conversion by combustion of these labeled substances to other forms is unnecessary. Compounds with multiple isotopic labels may also be counted by means of these systems. (auth)

40548 INTESTINAL ABSORPTION AND BODY RETENTION OF ^{47}Ca IN RATS: EVALUATION OF THE METHOD. Hertoghe, Jacques J.; Phinney, Sally B.; Rubini, Milton E. (Veterans Administration Center, Los Angeles). J. Nutr., 93: 454-60(Dec. 1967).

A method for study of the intestinal absorption and body retention of Ca in rats that required oral administration of ^{47}Ca and monitoring of the radioactivity with a whole-body counter is described. Extrapolation to zero time of the monoexponential portion of the body retention curve of ^{47}Ca was used to estimate net intestinal absorption. The slope of this curve provided an index of body retention of Ca. The validity of the estimate of intestinal absorption was confirmed by direct analysis of fecal, intestinal tract, and carcass content of ^{47}Ca after administration. Quantitative data on intestinal absorption and body retention of ^{47}Ca were obtained in various groups of normal rats of increasing weight and age. Growth and maturation had a depressing effect on both intestinal absorption and whole-body retention of ^{47}Ca. (BBB)

40549 DIFFERENT LOCALIZATION OF TETRACYCLINE AND SIMULTANEOUSLY INJECTED RADIOCALCIUM IN DEVELOPING ENAMEL. Hammarstroem, L. (Royal Veterinary Coll., Stockholm). Calcified Tissue Res., 1: 229-42(1967).

Distribution of tetracycline and ^{45}Ca, simultaneously injected as $CaCl_2$, was studied in the developing teeth of rats by fluorescence microscopy and autoradiography. Both substances accumulated in developing enamel, with great differences in their distributions. Distribution of ^{45}Ca supports the two-stage theory of mineralization, and tetracycline seemed mainly associated with the primary stage. Shortly after injection, both tetracycline and ^{45}Ca accumulated in a superficial zone in newly deposited enamel matrix. In addition, ^{45}Ca was taken up throughout the whole thickness of other areas of the enamel without corresponding accumulation of tetracycline. This uptake of ^{45}Ca was localized in the superficial zone. Between these two areas there was a superficial zone of increased fluorescence and autoradiographic blackening. Distribution of ^{45}Ca in the enamel remained unchanged during the four days of the investigation, but distribution of tetracycline was markedly changed with time. (BBB)

40550 EFFECTS OF IRRADIATION ON C, K, AND B GROUP VITAMINS. Gounelle, H.; Marnay-Gulat, C.; Fauchet, M.; Chacun, J. P. (Faculte de Pharmacie, Paris). Ann. Nutr. Aliment., 22: 39-40(1968). (In French).

Irradiation of vitamin K in a pure solution at a dose of 1 to 5 Mrad did not modify the anticoagulating activity as measured in the rat when the deficiency was induced by adding sulfadiazine and mineral oil to the diet. However, the color of the solution and the absorption spectrum were modified by irradiation indicating that some destruction of the vitamin resulted. Radioinduced inactivation of vitamins was studied in dried or suspended yeasts (Saccharomyces cerevisiae, strain CC 53-1) that were irradiated at a dose of 1 Mrad. Vitamins B_1, B_2, B_6, and PP were more radiosensitive in water than in the dry state. Definite destruction of vitamin B_1, slight inactivation of vitamin PP, and relative radioresistance in vitamins B_2 and B_6 were noted. Irradiation of suspensions of rice also destroyed vitamin B_1, while vitamins B_6 and PP were resistant to the various doses used (15, 100, 500, and 1000 Krad). Irradiation of potatoes at doses of from 10 to 100 Krad did not cause any immediate change in the vitamin C content, but after one week the inactivation increased in proportion to the dose. Similar results were observed in carrots irradiated under the same conditions. (BBB)

40551 INFLUENCE OF LOW TEMPERATURE ON THE ION ABSORPTION OF RICE ROOTS. Zsoldos, Ferenc (Jozsef Attila Univ., Szeged). Agrokem. Talajtan, 16: 653-8(Nov. 1967). (In Hungarian).

The influence of low temperature on the absorption of ^{32}P, ^{82}Br, and ^{86}Rb by rice roots (Oryza sativa var. japonica) was studied. The experiments were carried out on the roots of young (12- to 14-day-old) rice plants grown in water cultures. In short-term experiments (lasting 60 to 80 min) it was found that at low temperature the absorption of the various ions in KH_2PO_4 and RbCl solutions of 5×10^{-1} M concentration varied. While the adsorption of $PO_4-^{32}P$ and ^{82}Br anions always decreased with temperature, with ^{86}Rb, ion absorption began to increase again below 8°C. This unusual result is explained by the cold-shock effect which is likely to be caused mainly by sudden temperature changes. This effect was moderated by gradual cooling. It is known that under the influence of cold shock the permeability of cell membranes and consequently the absorption and the release of materials from the cell may change considerably. It was considered likely that in rice roots, the permeability of the membranes increased at low temperature and allowed a larger quantity of ^{86}Rb ions to penetrate the cells than under normal conditions. Since in the experiments the difference was seen only with ^{86}Rb absorption, it was likely that the shock effect is specific for various ions. It was assumed that ions having a common carrier behaved similarly. It was also established that at 10 to 12°C, the minimum germination temperature of rice seeds, no cold shock effect occurred. This meant that a reduced but yet regular ion absorption took place. (BBB)

40552 CURRENT TOPICS IN RADIATION RESEARCH. VOLUME IV. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1968. 438p. $19.00.

Seven chapters discuss different aspects of radiation research. These include radiation chemistry of hydrocarbons and of organic nitrogen compounds, genetic radiation damage and its repair in Escherichia coli, early radiation effects on nucleic acids of mammalian cells, restoration of radioinduced damage by nucleic acids, responses of cultured cells, tumors, and normal tissues to radiations of different LET, and the relation of biological effects to dose-time-fractionation factors in radiotherapy. A separate abstract was prepared for each chapter. (M.M.B.)

For abstracts of individual papers see: 40122, 40123, 40553, 40622, 40684, 40766, and 40869.

40553 EARLY EFFECTS OF IONIZING RADIATIONS ON NUCLEIC ACIDS. Swingle, Karl F.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco). pp 189-250 of Current Topics in Radiation Research. Vol. IV. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1968.

Interphase death of mammalian cells after low doses of ionizing radiation (usually less than 1000 rads) is reviewed. Morphologic, biochemical, and physical changes associated with early radioinduced death are described. Mechanisms of radioinduced DNA degradation are discussed including activation of DNAase I, activation of the substrate, and enzyme-substrate contact. The differences between radiosensitive and radioresistant interphase mammalian cells are considered with emphasis on the radiosensitivity of DNA, metabolic dependence of cells on DNA, and the repair of radiation-damaged DNA. 123 references. (M.M.B.)

40554 CHOLINESTERASE ACTIVITY IN THE RAT KIDNEY DURING EXPERIMENTAL INTOXICATION WITH URANYL NITRATE (BIOCHEMICAL AND HISTOCHEMICAL STUDY). Bastide, J.; Bastide, P.; Malet, P.; Turchini, J. P.; Dastugue, G. (Faculte Mixte de Medecine et Pharmacie, Clermont-Ferrand, France). Arch. Int. Pharmacodyn., 169: 320-7(Oct. 1967). (In French).

A study was made of hepatic and renal enzyme activity in the course of experimental poisoning of mice and rats with uranyl nitrate. Enzymatic activities were determined in homogenized mice kidneys. Poisoning with uranyl nitrate was obtained by single intraperitoneal injection of aqueous 2% uranyl nitrate solution in doses of 1 Ml per 100 g of body weight. The animals were killed 24, 48, 72, and 96 hr after injection. Twenty-four hr after administration of uranyl nitrate occurrence of toxic epithelial lesions of the tubulo-nephritis type was observed in certain areas of the renal parenchyma. Alterations in the cells of the convoluted tubules, massive exudation into the lumen (cylinder casts), less severe lesions in the glomeruli, and vascular congestion were seen. The same results were observed after 48, 72, and 96 hr postinjection. The severity of renal alterations was greater than that of lesions in the liver. Activity of total cholinesterase fell in kidney homogenates and that of true cholinesterase also dropped but less consistently. In plasma the activities fell then rose to higher than initial levels. Erythrocyte enzyme levels showed no significant changes. Enzyme and histologic changes were correlated. (BBB)

40555 AUTORADIOGRAPHY OF WATER-DIFFUSIBLE SUBSTANCES IN SECTIONS OF WHOLE BABY RATS. Aitken, W. M. (Wallaceville Animal Research Center, Wellington, N. Z.); Wright, Evan; Gray, H. S. Stain Technol., 43: 1-7(Jan. 1968).

Preliminary to investigation of radiomolybdenum and radioselenium in bony tissues, a method was devised to observe the gross distribution of these radioisotopes in whole rats at an early stage of development. Rats, seven days postnatal were injected with radionuclides, then quick frozen and sectioned in the frozen state. An adhesive cellulose tape (Sellotape) was used to support the section during cutting, through freeze-drying, and attaching to slides. Dehydration of the frozen sections consisted of 1 hr in a chilled desiccator containing silica gel, then at reduced pressure

of 2 to 3 mm Hg until quite dry. The exposed side of the section was sprayed with celloidin dissolved in amyl acetate and allowed to dry. This side of the section was attached to a slide, previously coated with 1% gelatin containing 0.1% chrome alum, by an adhesive consisting of 4% gelatin and 5% formalin in 60% glycerol. The adhesive was allowed to set for 20 min, the slide immersed in water for 50 sec, and the cellulose layer of the tape peeled off. The rubber base from the tape was removed with chloroform, the slide dried, and the exposed surface of the section coated with celloidin in amyl acetate, by dipping. After this treatment, the slides could be coated by dipping in autoradiographic emulsion without affecting water-soluble radioactive substances in the tissue. (BBB)

40556 CONFORMATIONAL DEGRADATION OF CYTOCHROME-C BY GAMMA IRRADIATION IN AQUEOUS SOLUTION. Yamauchi, Kotaro; Masuda, Takahiro; Kondo, Masaharu (Tokyo Metropolitan Univ.). J. Radiat. Res., 8: 14-19(Mar. 1967).

Conformational degradation of cytochrome-C induced by gamma rays in aqueous solution was studied. The formation of CO-affinitive cytochrome-C, susceptibility of cytochrome-C to proteinase, and spectrophotometric titration of tyrosyl residues were investigated. These results indicate that gamma irradiation in aqueous solution degrades cytochrome-C and decomposes polypeptide to give exposed heme or tyrosyl residues that are embedded within a protein component. (auth)

40557 CHANGES IN THE ACID STABILITY OF THE RED BLOOD CELL MEMBRANES AFTER TREATMENT WITH ULTRAVIOLET RAYS. Vransky, V.; Zafirov, I. (Univ. of Medicine, Sofia). Stud. Biophys., 2: 71-8(1967).

Changes in the acid stability of the red blood cell membranes were investigated after irradiation with different doses of ultraviolet rays. It was established that the greatest changes occur after irradiation of blood diluted in physiological solution and almost none in cases of blood with a normal addition of sodium citrate. The results obtained are the first steps in clarifying some biophysicochemical mechanisms on which an autochemotherapeutic method is based. (auth)

40558 REASONS FOR THE VARIATION OF THE QUANTITY OF GLYCOGEN IN HEPATIC TISSUES IN IRRADIATED ANIMALS. Movsesyan, M. A.; Mnatsakanyan, K. A.; Barkhudaryan, L. Kh. (Inst. of Roentgenology and Oncology of Ministry of Public Health, Erevan). Zh. Eksp. Klin. Med., 7: No. 5, 3-8(1967). (In Russian).

With studies carried out on rabbits and rats, it is established that in the initial period of acute radiation sickness the changes in the quantity of glycogen strictly depend on the gravity of the radiation sickness; in a light attack the quantity of glycogen is increased, but in a grave attack it is decreased. This was explained by the fact that in the initial period of a light case of radiation sickness the glycogen formation is stimulated, but in a grave case it is depressed. During radiation sickness the glycogenesis in the irradiated starving animals is inhibited in comparison with non-irradiated animals subjected to starving. In the crisis stage of radiation sickness, impoverishment of glycogen in the liver occurs; the degree of decrease of the quantity of glycogen has a direct relation to the gravity of the sickness. The basic reason for the impoverishment of the glycogen in this stage of illness is the partial starvation of the animals, but during grave illness inhibition of glycogen formation occurs in addition. (tr-auth)

40559 THE EFFECT OF ULTRAVIOLET LIGHT ON THE INTRACELLULAR STABILITY OF THE DNA OF BACTERIOPHAGES T2 AND T4. Masamune, Yukito (Tokyo Univ.). Mol. Gen. Genet., 101: 99-110(1968).

Sedimentation of DNA in alkaline sucrose gradients was used to demonstrate the presence of cross-links between the strands of T2 DNA that were irradiated with ultraviolet light. Escherichia coli was infected with T4 wild, T4V or T4X that was irradiated with uv. The DNA was found to be degraded soon after the infection although it did not become acid-soluble. Ultraviolet irradiation of phage T2 provoked neither double-strand nor single-strand breaks. Mixed infection of T2 and T4 provoked the breakdown of T2-DNA but not of T4-DNA. This effect may be related to the partial exclusion of T2 by T4. The DNA of T2 irradiated with uv was shown to be degraded when uv-T2 was mixedly infected with T4. (auth)

40560 ACTION OF ULTRAVIOLET RAYS ON BACTERIOPHAGE λ. Krsmanovic-Simic, D.; Miller-Faures, A. (Univ., Brussels). Arch. Int. Physiol. Biochim., 76: 185-6(Feb. 1968). (In French).

The study of photochemical lesions of DNA in bacteriophage λ induced by uv irradiation was undertaken by several methods. Phage λ was irradiated in phosphate buffer at pH 7.5 and its DNA then extracted by $NaClO_4$. Electron microscopic observations of DNA of phage irradiated with relatively high doses (starting at 15×10^3 erg/mm^2) showed diminution in molecular length, a reticulated aspect, and association of DNA with the phage envelope. The perchloric acid extract was then studied by centrifugation in sucrose density gradients. Progressive diminution of the 30S peak (DNA intact) and 50S peak (partially liberated DNA) was noted, with the appearance of heterogeneous zones above 30S and below 50S. The fraction of phage surviving the dose 15×10^3 erg/mm^2 was 0.02% and it was shown that ruptures in the two chains of DNA or the DNA-protein bonds were the main cause, under the given conditions, of the loss of infectivity. DNA of phages marked with thymidine-2-^{14}C was given lesser doses at a neutral or alkaline pH. The 30S DNA from irradiated phage (6×10^3 erg/mm^2, survival 0.2%) became strongly heterogeneous in the low sucrose density regions after an irradiation dose of 15×10^3 erg/mm^2; the degree of heterogeneity was of the same order. It was inferred that a superposition of two effects took place: rupture of DNA chains and intermolecular bonds. (BBB)

40561 THE FACTORS AFFECTING THE STRENGTH OF "ONE-WAY" STIMULATION WITH IRRADIATED LEUKOCYTES IN MIXED LEUKOCYTE CULTURES. Kasakura, Shinpei; Lowenstein, Louis (Royal Victoria Hospital, Montreal. McGill Univ. Clinic, Montreal). J. Immunol., 101: 12-17(July 1968).

The factors affecting the strength of unidirectional stimulation by irradiated cells in mixed leukocyte cultures were investigated. Nonspecific factors included the number of irradiated cells used in the cultures, the dose of x ray, the time interval between the end of irradiation and preparation of the cultures, and the length of incubation of the cultures. Results suggested that a satisfactory radiation level for unidirectional quantitation may be 4000 R. The results also indicated that individual-specific factors can affect one-way responses. These factors may be based on histocompatibility differences between the donors of responding and stimulating cells. (auth)

40562 EFFECT OF GAMMA RADIATION ON PLASMA ALKALINE PHOSPHATASE ACTIVITY. Gajewski, A. K.; Raczynska-Gajewska, J.; Majle, T.; Krawczynski, J. (Inst. of Radiation Protection and Radiobiology, Warsaw). Acta Physiol. Pol., 19: 367-73(May-June 1968). (In Polish).

Wistar rats were irradiated with lethal and sublethal doses of gamma radiation. The animals were divided into six experimental groups. Four groups, numbering ten animals each, were irradiated with doses of 250, 500, 1000, and 1500 R. In these groups, blood samples were obtained from the tail vein before irradiation and 11 times in the course of 30 days after irradiation. Two groups numbering five animals each were irradiated with doses of 250 and 1500 R, and blood samples were obtained before irradiation and six times in the course of 24 hours after irradiation. Alkaline phosphatase activity was assayed in a total of 432 blood samples. Alkaline phosphatase activity was decreased within minutes or hours after irradiation. Lowest levels of activity in the plasma were observed on the fourth or fifth day after irradiation. After that, the enzyme's activity increased. In animals irradiated with sublethal doses, alkaline phosphatase activity returned to the normal level two or three weeks after irradiation. The drop in enzymatic activity was not proportional to the dosage of radiation applied. (auth)

40563 CONTRIBUTION OF HOST RESISTANCE TO RADIOSENSITIVITY OF AN ISOLOGOUS MURINE LYMPHOMA IN VIVO. Maruyama, Yosh; Manthe, J. (Univ. of Minnesota, Minneapolis). Int. J. Radiat. Biol., 12: 277-92(1967).

LSA ascites lymphoma cells were irradiated in vitro and assayed in vivo in isologous recipients. Results with the TD50 method were correlated with a separate assay using an inoculum containing a fixed total number of tumor cells and measuring the 50% sterilization dose (SD50) of x radiation. Comparison of sham- and pre-irradiated recipients showed differences which were consistent with the presence of isoantigenic tumor antigens, using the SD50 method. Host-resistance against the tumor was reduced by irradiation of the recipients, but significant differences were only evident when cell inocula were large. Isologous tumor resistance was found to become of progressively greater significance with larger numbers of radiation-killed cells. Host-resistance factors appeared to increase apparent shoulder size (or extrapolation number), decrease D_0, and convert a linear exponential survival curve to a more parabolic one. Host-resistance factors could contribute to cell-survival response in vivo without prior exposure of recipients (i.e., active immunization) to the living or killed tumor. (auth)

40564 THE EFFECT OF X IRRADIATION ON THE ACTIVITY OF LIPOPROTEIN LIPASE IN INTERSCAPULAR ADIPOSE TISSUE OF THE RABBIT. Wooles, W. R. (Medical Coll. of Virginia, Richmond). Radiat. Res., 34: 596-603(1968).

Lipoprotein lipase (LL) activity and the uptake of palmitic acid-1-^{14}C of the interscapular fat pad of the rabbit were studied in pair-fed animals prior to and during the development of hypertriglyceridemia following exposure to 1000 R x radiation. The concentration of plasma triglyceride of irradiated rabbits was similar to control values at 2 hours after exposure and was increased 582% and 398% above control levels at 16 and 24 hours. Liver triglyceride concentration of the irradiated groups was increased 73% and 88% above control levels at 2 and 16 hours after exposure and was similar to control values at 24 hours. Lipoprotein lipase activity of the interscapular fat pad of irradiated rabbits 2 hours after exposure was increased 94% above control levels. At 16 hours after exposure, at the peak of irradiation induced hypertriglyceridemia, lipoprotein lipase activity of the irradiated group was decreased 84% below the activity manifested by the control group. By 24 hours post-irradiation LL activity of the irradiated group was similar to control levels. The increase in LL activity 2 hours after exposure was associated with an 83% increase in incorporation of the label into this adipose tissue site. However, at 16 and 24 hours after exposure no further increase in the incorporation of the label above the level manifested at 2 hours was observed. The results demonstrate that exposure to 1000 R produces a biphasic response in LL activity of interscapular adipose tissue. The early increase in LL activity may be a factor in the increased intervascular removal rate of exogeneous lipoproteins reported to occur in the first 12 hours post-irradiation. The subsequent inhibition of LL activity and associated decrease in incorporation of the labeled palmitate in this adipose tissue site suggest that they are factors involved in the genesis of postirradiation hypertriglyceridemia. (auth)

40565 NEUROSECRETION IN THE HYPOTHALAMUS AND POSTERIOR PITUITARY AFTER IRRADIATION AND INJECTION OF CHEMICAL RADIOPROTECTORS IN THE RAT. Duchesne, P. Y.; Hajdukovic, S.; Beaumariage, M. L.; Bacq, Z. M. (Univ., Liege. Laboratoire de Recherches, Liege). Radiat. Res., 34: 583-95(1968).

Acute whole-body exposure to 800 to 200 R of 200-kV x rays induced instant activation of the neurosecretory processes in the hypothalamus and posterior hypophysis in rats, as observed by histochemical techniques. The same neurosecretory response was observed after exposures to 700 or 400 R or x rays delivered at an exposure rate of 10 R/min as well as after exposures to 1000 or 800 R of ^{137}Cs γ rays at the rate of 1 R/min. Partial irradiation of the head alone or irradiation of the animal's body, with the head shielded, induces the same neurosecretory response. These results, added to previous information, suggest that the neurosecretory response to lethal or sublethal doses constitutes an important and necessary link in the stress reaction of mammals to ionizing radiation. Cysteamine (150 mg/kg of body weight in intraperitoneal injection) and cystamine (same radioprotective dose) stimulated the neurosecretion of normal nonirradiated rats. Subsequent exposure to x rays (700 R or 400 R) further intensified this process. (auth)

40566 EFFECT OF ULTRAVIOLET RADIATION ON β-GALACTOCIDASE AND PROTEIN SYNTHESIS DURING STARVATION FOR ESSENTIAL SUBSTANCES BY E. COLI 15 THU. Masek, Frantisek; Sedliakova, Milena (Biological Inst., Bratislava). Biologia (Bratislava), 23: 200-5(1968).

The effect of uv radiation on β-galactocidase (BG) and protein syntheses by E. coli 15 THU cultures, influenced in preirradiation phase by thymine, uracil, or energetic starvation was determined. The samples starved for thymine prior to the irradiation showed after the irradiation a decreased rate of BG synthesis in comparison with the rate of synthesis of total protein. On the basis of experimental conditions it is suggested that the studied effect is not a result of inhibited synthesis of galactoside permease, but rather a case of synthesis of either non-functional protein or a less stable enzyme. (auth)

40567 THE INFLUENCE OF GAMMA RAYS ON GROWTH AND SOME ENZYMATIC FUNCTIONS OF STREPTOCOCCUS LACTIS. Oberman, H.; Makiedonska, A. (Technical Univ., Lodz, Poland). Rocz. Technol. Chem. Zywn., 14: 83-107(1967). (In Polish).

Effects of gamma radiation on survival, growth, acidifying ability, and gaseous exchange in Streptococcus lactis in several substrates were studied. The lethal dose was 350,000 rads for a water suspension of 10^9 cells per ml. There was no relation between enzyme activity and radioinduced inactivation of cells as evidenced by lack of growth in culture media. A reduction of 99% of viable cells did not inhibit metabolism or gaseous exchange in substrates of resting cells. Repeated irradiation of organisms did not induce radioresistance, but a selection of less sensitive cells occurred. Inactivated cells stored for 24 hr at 4°C showed more normal respiration than irradiated cells. (H.L.W.)

40568 NUKLEINOVYE KISLOTY I BIOLOGICHESKOE DEISTVIE IONIZIRUYUSHCHEI RADIATSII, MATERIALY SIMPOZIUMA, 9–11 DEKABRYA 1965. (Nucleic Acid and Biological Effect of Ionizing Radiation, Materials of the Symposium, December 9–11, 1965). Kuzin, A. M. (ed.). Moscow, Izdatel'stvo Nauka, 1967. 200p. (NP–17540).

The mechanism of ionizing radiation effects on desoxyribonucleoproteins; radio-chemical injuries to DNA in vitro and in vivo; and the influence of ionizing radiation on the epimolecular structure of DNA in cells are discussed in the first four articles. Nucleic acid metabolism in irradiated organisms and radiation effects on DNA synthesis control mechanisms are covered in the next three articles. Radiosensitivity of the information transmission functions in DNA molecules and radiation effects on the synthesis of RNA information molecules at various stages of embryonic development are discussed in the last three articles. General problems in biochemical and biophysical research with biological macromolecules are also reviewed. (R.V.J.)

40569 EFFECT OF WHOLE-BODY X-IRRADIATION ON α-GLUCAN PHOSPHORYLASE ACTIVITY IN LIVERS OF INTACT AND ADRENALECTOMIZED RATS. Yago, Nagasumi; Kobayashi, Shigeru; Omata, Saburo; Ichii, Shogo (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 8: 65-71(June 1967).

The effect of lethal doses (1000 R) of whole-body x irradiation on levels of α-glucan phosphorylase and glycogen in livers of intact and adrenalectomized rats was studied. Both total and resting activities of α-glucan phosphorylase in livers of irradiated, fasted rats remained at the level of unirradiated, ad libitum fed rats for a total period of 72 hours post-irradiation. This was in contrast with the progressive decrease in the activity of this enzyme in unirradiated, fasted rats. Whole-body x-irradiation of adrenalectomized rats did not appear to afford any such effect of maintaining the level of α-glucan phosphorylase higher than unirradiated, fasted animals. The relationship between levels of α-glucan phosphorylase and glycogen in livers of irradiated rats was discussed. (auth)

40570 PREPARATION OF LABELED LIPIDS. Mangold, Helmut K. (Univ. of Minnesota, Austin). J. Label. Compounds, 4: 1-9(Jan.-Mar. 1968).

Emphasis is placed on the description of advances made in the synthesis and biosynthesis of labeled neutral lipids, phosphatides, and other complex ionic lipids. Methods applicable to the analysis and purification of these compounds are described briefly. Observations related to the autoradiolysis of labeled lipids during storage are discussed. The isotopes used are chiefly ^{14}C, ^{3}H, ^{32}P and ^{35}S. (auth)

40571 RADIOLYSIS IN AQUEOUS SOLUTION OF AROMATIC AMINO ACIDS. Ohara, Akira; Toda, Kimiko (Kyoto Coll. of Pharmacy, Japan). J. Radiat. Res., 8: 45-52(June 1967).

Radiolysis of tyrosin, phenylalanine and 3,4-dihydroxyphenylalanine in aqueous solution was studied quantitatively. It was found that γ-irradiation caused (oxidative) deamination, yielding ammonia and the corresponding α-keto acids. Comparison of the rate of radiolytic decomposition showed that of the three amino acids, phenylalanine is most sensitive and tyrosin is most resistant to γ-radiation. (auth)

40572 THE USE OF TRITIUM OXIDE AS A BIOSYNTHETIC PRECURSOR OF MACROMOLECULES IN BRAIN AND LIVER. Metzger, H. Peter (Univ. of Colorado, Boulder); Cuenod, Michel; Grynbaum, Alice; Waelsch, Heinrich. J. Neurochem., 14: 99-104(Jan. 1967).

A method was described for measuring the uptake of tritium, from tritium oxide, into various chemical fractions of subcellular components of tissues. This resulted in a constant level of radioactivity that persisted for at least five hr in blood water and brain water. There was no difference between the specific radioactivities of blood and brain water during this period. On the basis of dilution of the injected tritium-labeled water, water space of the rats was about 60 ml/100 g of body wt. The method used for determining tritium incorporation into three chemical fractions of rat liver produced results of high precision. When the averages of the corresponding chemical fractions were compared, the largest standard deviation was 7.1%. The methods used for the isolation of subcellular components followed standard biochemical techniques with the exception of the method for the isolation of synaptic endings. Here a method based on that for the isolation of brain mitochondria was used, resulting in a preparation with a high concentration of synaptic endings. For study of tritium incorporation into the protein of monkey brain, a monkey (Macaca mulatta) was injected intraperitoneally with tritium-labeled water (25 mCi/Kg). The results of the tritium incorporation at four hr into the protein of the various subcellular fractions of monkey

cortex showed that the ratios of corresponding fractions from each hemisphere were very close to unity, the average of the ratios being 0.98 ± 5.9%. (BBB)

40573 METABOLISM OF ^{75}Se-SELENITE, ^{75}Se-SELENATE, ^{75}Se-SELENOMETHIONINE AND ^{35}S-SULFATE BY RUMEN MICROORGANISMS IN VITRO. Paulson, G. D. (State Univ., Fargo, N. D.); Baumann, C. A.; Pope, A. L. J. Anim. Sci., 27: 497-504(Mar. 1968).

Comparisons were made of the in vitro metabolism of ^{75}Se-selenomethionine, ^{75}Se-selenite, ^{75}Se-selenate, and ^{35}S-sulfate by rumen microorganisms of sheep. There was a gradual incorporation of ^{35}S activity into the trichloroacetic acid (TCA) insoluble fraction of the rumen fluid that could be inhibited by excess sulfate. The incorporation of ^{35}S into methionine was confirmed by paper and ion exchange chromatography. There was a gradual incorporation of ^{75}Se-selenomethionine into the TCA-insoluble fraction of the rumen fluid which could be inhibited by excess methionine; pronase released most of the activity from the TCA-insoluble fraction, 60% of which was identified as ^{75}Se-selenomethionine by paper and ion exchange chromatography. Radioactivity added to the rumen fluid as ^{75}Se-selenite and ^{75}Se-selenate was rapidly incorporated into the TCA-insoluble fraction. However, most of the activity added as inorganic ^{75}Se was apparently loosely bound and could be removed by dialysis when reduced glutathione was in the dialysis bath. The binding of ^{75}Se-selenite was not enzyme dependent. The incorporation of inorganic ^{75}Se into the TCA-insoluble fraction was not inhibited by excess sulfate, and very little or none of the activity added to the rumen fluid as ^{75}Se-selenite or ^{75}Se-selenate was incorporated into ^{75}Se-selenomethione. (BBB)

40574 ABILITY OF ^{47}Ca KINETIC ANALYSIS TO DISCRIMINATE METABOLIC STATES AFFECTING BONE FORMATION IN DOGS. Riggs, B. Lawrence; Jowsey, Jenifer; Ackerman, Eugene; Hazelrig, Jane B. (Mayo Clinic, Rochester, Minn.). Metab., Clin. Exp., 16: 1064-73(Nov. 1967).

Rates of bone remodeling by simultaneous determinations of two parameters that are somewhat independent reflections of the remodeling process were investigated. One of the parameters, the F ratio, was defined as the ratio of the length of internal surface at which bone formation is active (assessed by microradiography and confirmed by tetracycline labeling) to the total length of internal surface in both sections from biopsy sites. The second was an empiric parameter with calculations based on measurements of ^{47}Ca in plasma at various times after intravenous injection and on the amount of ^{47}Ca excreted. Three groups of dogs differing in their hormonal balance and, hence, in their overall rates of bone remodeling were studied. The results showed that there was comparatively little overlap in the ranges of ^{47}Ca values. Within any one of the groups values were not correlated. It was shown that knowledge of both values can provide better discrimination among these three groups than could be achieved with either parameter alone. (BBB)

40575 RESTORATION OF THE IMMUNE RESPONSE BY CIRCULATING LYMPHOCYTES. Cannon, Donald C.; Wissler, Robert W. (Argonne Cancer Research Hospital, Ill.). Arch. Pathol., 83: 188-98(Feb. 1967).

Rat spleens were exteriorized and x-irradiated while the body was protected by lead shielding. A dose of 600 R was used; this dose resulted in marked atrophy of lymphoid tissue and inhibition of humoral antibody formation in unshielded control animals. The spleen was again exteriorized 24 hr later and was shielded while the remainder of the body was x-irradiated at 600 R. In this way all cells of the body were exposed to an identical dose of irradiation except for those cells that migrated from other tissues of the body to the spleen during the 24 hr between the 2 exposures to irradiation. It was reasoned that if the spleen participated in the recirculating lymphocyte pool, it should be repopulated with lymphocytes following the first irradiation. The ability of these lymphocytes to restore immunological function to the spleen was then evaluated by administering antigen after the second irradiation. Results showed that circulating lymphoid cells which rapidly repopulated the spleen were capable of restoring to a considerable degree its ability to exhibit red pulp hyperplasia in response to an injection of Salmonella typhosa vaccine. Similarly, there was considerable protection of the animals' ability to form circulating agglutinins. As compared with unirradiated animals, the circulating agglutinin titer in animals irradiated in this fashion had a slower rise to peak titer, although the maximum titer reached was similar. (BBB)

40576 FORMATION OF CYTASTERS IN AMPHIBIAN EGGS AFTER TREATMENT WITH HEAVY WATER. Van Assel, S.; Brachet, J. (Univ. Libre, Brussels). J. Embryol. Exp. Morphol., 15: 143-51(Apr. 1966). (In French).

Formation of cytasters and other evidence of mitotic disorders occur in a variety of ova exposed to D_2O. To examine these effects of D_2O more closely, amphibian eggs were subjected to the action of heavy water at high concentration (50% or 100%). Treatment resulted in rapid arrest of mitotic activity in newly fertilized eggs and the appearance of many cytasters in unfertilized and fertilized eggs. A study of these cytasters indicated that they were formed in the hyaloplasm and that they appeared simultaneously. The cytasters decreased in number and increased in size when the eggs were placed in normal H_2O medium. Electron microscopy showed that the cytasters were formed from astral fibers and that they possibly contained centrioles. Further studies of cytaster formation in D_2O should clarify the mode of their formation and their relation to nucleic acid and protein synthesis. (BBB)

40577 MODIFICATIONS OF THE LIBERATION OF THE MEDIATOR AT THE NEUROMUSCULAR JUNCTION UNDER THE ACTION OF THE URANYL ION. Mambrini, Jean; Benoit, Pierre-Rene (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. D, 266: 1145-8(Mar. 11, 1968). (In French).

The uranyl ion, at a concentration of 0.2 mM/1, prolonged the action potential of the Grenouille motive fibers of Rana esculenta, at the level of the Ranvier constriction and at the presynaptic termination. It caused, in particular, an increase of the mean quantum content of the motive plate potential accompanied by an increase of the minimum synaptic delay, phenomena that can be related to the elongation of the presynaptic depolarization. Nevertheless the uranyl ion exercised an action facilitating in a more general character the liberation of the mediator, as the considerable increase of the mean frequency of the miniature potentials shows. (tr-auth)

40578 ^{133}Xe-RADIOSPIROMETRY IN RABBITS WITH SOME OBSERVATIONS ON UNILATERAL HYPOXIA. Dale, Knut (Inst. of Occupational Health, Oslo). Acta Physiol. Scand., 71: 163-7 (Oct.-Nov. 1967).

Radiospirometry with ^{133}Xe can replace bronchospirometry in man. With the equipment and procedures described the method of ^{133}Xe radiospirometry was tested in rabbits. The results obtained proved reproducible. Bronchospirometry in small animals involved a considerable narrowing of the bronchus lumen with influence on the ventilation, and it would thus disturb steady-state evaluations. In the present experiments such catheterization with narrowing of a bronchus was carried out to test the effect of rebreathing. The ^{133}Xe technique could be applied without any bronchus catheterization, and so it did not influence ventilation at all. The respiratory gases prompted vasoconstrictor response to alveolar hypoxia in most species, whereas in rabbits there was a much less marked and more gradual effect. In rebreathing experiments hyperventilation with alkalosis could to some extent counteract the hypoxic effect on the pulmonary vessels. The moderate and gradual fall in pulmonary blood flow found during unilateral hypoxia indicated that the ^{133}Xe radiospirometric method described might be useful in studies of this type. (BBB)

40579 VARIATIONS IN SOLUBLE PROTEINS AND FATS IN TOTAL-BODY IRRADIATED ALBINO RAT MYOCARDIUM. Notario, A.; Doneda, G.; Pallavicini, E. Bobbio; Slaviero, G. E. (Univ., Pavia, Italy). Minerva Radiol., Fisioter. Radiobiol., 12: 454-63(Nov. 1967). (In Italian).

The literature concerning the anatomical and functional changes induced in the myocardium and in the coronary circulation by exposure to irradiation is briefly reviewed. The results of a study of changes in the pattern of free cytoplasmatic proteins and fatty acids in normal rat heart after a single lethal dose and non-lethal divided doses of x radiation are reported. Increases in gamma globulins and decreases in beta globulins, and (to a lesser extent) alphaglobulins, were found to be in direct proportion to radiation dose and to the length of time between total-body lethal irradiation and sacrifice. Total fatty acids showed clear signs of change but patterns varied in relation to the dose employed. The most constant findings were: decreases in palmitic acid and, particularly in the lethally irradiated animals, stearic acid; increases in oleic, linoleic and arachidonic acids; in consequence, lowering of the saturated/non-saturated fatty acid ratio. The significance of these changes and their probable importance in the understanding of radiation-induced myocardial insufficiency are briefly discussed. (auth)

40580 CONTRIBUTION TO THE STUDY OF RADIOSENSITIVITY OF MICROCOCCUS RADIODURANS DNA. Bohacek, J.; Blazicek, G. (Inst. of Biophysics, Brno). Stud. Biophys., 2: No. 1, 13-18(1967).

The method of thermal denaturation was used to follow the stability of DNA structure after γ-irradiation in vitro, using DNA samples of approximately same value of guanine cytosine content

isolated from radioresistant and radiosensitive strains. DNAs were exposed to 10^5 R (obtained from ^{60}Co γ-rays source) and the denaturation curves were recorded 24 hrs after irradiation using solutions of 40 μg DNA/ml 10^{-2} M sodium phosphate buffer + 10^{-3} M EDTA at pH 7. It was concluded that there were no differences in stability of DNAs of various GC content even though isolated from bacteria differing in sensitivity to γ-radiation. (auth)

40581 ACUTE OCCUPATIONAL CADMIUM POISONING: A CRITICAL REVIEW OF THE LITERATURE. Dunphy, Barry. J. Occup. Med., 9: 22-6(Jan. 1967).

This review presents information on acute occupational cadmium poisoning in respect to occurrence, etiology, pathology, symptomatic response, diagnosis, treatment, and prevention. (Public Health Eng. Abstr.)

40582 STRUCTURAL DEFECTS IN DNA AND THEIR REPAIR IN MICROORGANISMS. Proceedings of a Conference on Radiation Microbiology, Univ. of Chicago, Oct. 18-20, 1966. Radiat. Res., Suppl. 6, 243p.(1966).

Proceedings of a Conference on Radiation Microbiology sponsored by the National Academy of Sciences, National Research Council of the United States of America, and University of Chicago, Illinois, October 18 to 20, 1965. (Public Health Eng. Abstr.)

40583 DISTRIBUTION AND EXCRETION OF NIOBIUM FOLLOWING INHALATION EXPOSURE OF RATS. Thomas, Robert G. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.); Thomas, Randi Lie; Scott, James K. Amer. Ind. Hyg. Ass. J., 28: 1-7(Jan.-Feb. 1967).

The pattern of buildup and loss of ^{95}Nb from the whole body indicated that the hazard from chronic inhalation of this material could be assessed from calculations based on data derived from a single exposure. (Public Health Eng. Abstr.)

40584 THE INFLUENCE OF NEUROHORMONES ON CO_2 EXCRETION AND CARBOHYDRATE METABOLISM IN ACUTE POSTRADIATION DISEASE IN RATS. Kulesza, Romuald (Warsaw Inst. of Radiation Protection and Radiobiology). Acta Physiol. Pol., 19: 375-86(May-June 1968). (In Polish).

Experiments were designed to study regulation of basal metabolism and carbohydrate metabolism in postradiation disease in rats treated with acetylcholine, adrenaline, histamine, noradrenaline, and serotonin. The animals were x-irradiated with doses of 700 R. Two series of experiments were performed. In the first series, basal metabolism was determined on the basis of amount of CO_2 exhaled by the rat. Measurements were made by means of a carbon dioxide analysor with continuous recording. In the second series, using apparatus adapted to studies with radioactive isotopes, kinetics of ^{14}C/U/glucose metabolism were studied in the rats. On the basis of the results, it was concluded that in acute postradiation disease in rats adrenaline and noradrenaline exert a regulating influence on disorders of basal metabolism, while acetylcholine, noradrenaline and serotonin regulate carbohydrate metabolism. (auth)

40585 EFFECTS OF SODIUM ALGINATE ON ABSORPTION AND DEPOSITION OF RADIOACTIVE CATIONS IN THE CHICK. Colvin, L. B. (Texas A and M Univ., College Station); Creger, C. R.; Couch, J. R. Proc. Soc. Exp. Biol. Med., 124: 566-8 (Feb. 1967).

Data indicated that sodium alginate was not effective in selectively inhibiting the absorption of ^{89}Sr while permitting ^{45}Ca to proceed unhindered. The skeletal deposition of ^{89}Sr was essentially unchanged, whereas, ^{45}Ca was reduced by increased amounts of dietary sodium alginate. An amount of dietary kelp equivalent to 1% sodium alginate decreased ^{45}Ca deposition, but increased ^{89}Sr deposition. (Public Health Eng. Abstr.)

40586 GAMMA IRRADIATION STUDIES WITH SYNTHETIC POLYAMINO ACIDS. STUDIES WITH POLY-L-TYROSINE AND POLY-DL-ALANINE USING MONOLAYER TECHNIQUE. Korgaonkar, K. S.; Joshi, Sindhu V. (Cancer Research Inst., Bombay). Radiat. Res., 35: 213-26(1968).

Monolayer properties of poly-L-tyrosine (D.P.39) and poly-DL-alanine (D.P.24) were studied at air–water interphase prior to, and after their gamma irradiation in dilute aqueous solutions at a dose rate of 1.5×10^5 R/hr. Both these polyamino acids spread to a lesser extent than 1 m^2/mg and also exhibited strong association phenomena. From the observed significantly low values for packing areas as well as areas at minimum compressibility, a possibility of the molecules being in α-configuration at the interphase was suggested. Marked reductions in the spread areas were noted in the irradiated samples. Examination of changes in the molecular weights, and in total and actual areas occupied by the molecules indicated relative stability of the peptide bond against radiation attack. This was further confirmed in the case of poly-DL-alanine by the study of ultraviolet absorption at 200 mμ, caused by the peptide chromophore. Cross-linking effect of irradiation was also evident in this molecule. Radiation did not seem to affect association in either poly-L-tyrosine or poly-DL-alanine. (auth)

40587 DEOXYRIBONUCLEIC ACID SYNTHESIS DURING THE FIRST POST-IRRADIATION LIFE CYCLE OF LETHALLY IRRADIATED CULTURED MAMMALIAN CELLS (L5178Y). Watanabe, I.; Okada, S. (Univ. of Rochester, N. Y.). Contract W-7401-eng-49. Radiat. Res., 35: 202-12(1968). (UR-49-821).

A method that combined the principles of the window technique and the double emulsion radioautographic study of ^{14}C- and ^{3}H-labeled cells was developed to study DNA synthesis of mouse leukemic cells as they passed through the S period. With this method, it was shown that the radiation caused a depression of DNA synthesis followed by the recovery of DNA synthesis to a rate that was faster than that of nonirradiated cells. The irradiated cells were able to synthesize more DNA than the nonirradiated control cells. A DNA degradation process similar to that in bacteria was not detected in the lethally irradiated cells. The findings were discussed in relation to cell death. (auth)

40588 ROLE OF THYMUS IN ADOPTIVE TOLERANCE. Argyris, Bertie F. (Syracuse Univ., N. Y.). J. Immunol., 100: 1255-8(June 1968).

Specific homograft tolerance was induced in neonatal C3H mice with CBA spleen cells. These mice were test-grafted with CBA skin. After bearing successful CBA skin grafts for 2 months or longer they served as donors for tolerant thymus and bone marrow transplants. Adult intact and thymectomized C3H mice were x irradiated and injected with 10 million tolerant bone marrow cells. The thymectomized mice were, in addition, supplied with a subcutaneous tolerant thymus graft. The irradiated recipients of tolerant thymus and tolerant bone marrow accepted CBA skin, demonstrating adoptive tolerance. They also rejected C57Bl/6 skin, demonstrating that tolerant thymus can reconstitute immune recovery of thymectomized, irradiated bone marrow treated mice. Nontolerant thymus grafts were unable to abolish the transfer of adoptive tolerance by tolerant bone marrow, both in intact and thymectomized irradiated recipients. Tolerant thymus was capable of imposing specific homograft tolerance on irradiated recipients of nontolerant bone marrow, especially if these recipients were thymectomized at the time of irradiation. These results support the evidence of others that thymus plays an important role in immunologic tolerance. (auth)

40589 BIOCHEMICAL LESIONS INDUCED IN SUBCELLULAR STRUCTURES BY IONIZING RADIATION. PART IV. THE ACTIVITY OF PHOSPHOGLUCOMUTASE, PORPHOBILINOGEN SYNTHASE, AND FERROCHELATASE IN RAT LIVER AND SPLEEN. Dancewicz, Antoni; Panfil, Barbara (Inst. of Nuclear Research, Warsaw). Nukleonika, 12: 255-62(1967).

The article reports on experimental studies leading to an evaluation of certain enzyme activities in irradiated animals. In isolated subcellular fractions from rat liver and spleen, the protein concentration was determined as protein nitrogen according to the Kjeldahl method where the effect of PGM and PBG synthase was examined; the Lowry method of protein determination was used in tests with ferrochelatase. All results are tabulated showing the effect of whole-body irradiation on the respective activities of these enzymes. The subcellular fractions examined were a) mitochondrial, b) microsomal, c) soluble, and except with PGM, d) nuclear. It appeared that soluble enzymes were inactivated by irradiation in vivo, while the activity of enzymes bound to subcellular particles either remained unchanged or increased. A different intercellular localization of ferrochelatase in homogenates of spleen should explain the anomalous decrease of this enzyme's activity here. (JPRS)

40590 FERROCHELATASE ACTIVITY IN NORMAL AND IRRADIATED ANIMAL TISSUES. Goudy, B.; Dawes, E.; Wilkinson, A. E.; Wills, E. D. (Medical Coll. of St. Bartholomew's Hospital, London). Eur. J. Biochem., 3: 208-12(Dec. 1967).

Ferrochelatase activity was assayed in mouse tissues and subcellular fractions after whole-body irradiation and in rat tissues and subcellular fractions after irradiation in vitro. Ferrochelatase in tissue homogenates, mitochondria, or in a purified form was not affected by 50 Krad in vitro but was 15 to 30% inhibited after storage of irradiated samples for 20 hr at 4°. In liver, heart, and muscle homogenates the activity of ferrochelatase in mice irradiated with a whole-body dose of 850 rad was not outside the range of control values. However, in kidney, spleen, bone marrow, and in liver and kidney mitochondria there was an increase of enzyme ac-

tivity on the 3rd day after irradiation, followed by a decrease and return to normal on the 9th to 10th days. A decline in ferrochelatase activity probably cannot account for the accummulations of iron found in tissues of irradiated animals and its importance as a site of radiation damage in vivo appeared unlikely. (BBB)

40591 DNA DEGRADATION BY IONIZING RADIATION IN BACILLUS SUBTILIS. SYNERGISTIC EFFECT OF ACTINOMYCIN D. Grady, Leo J.; Pollard, Ernest C. (Pennsylvania State Univ., University Park). Biochim. Biophys. Acta, 145: 837-9 (Oct. 16, 1967).

Cultures of Bacillus subtilis were divided into three equal portions. The first portion was exposed to γ radiation after addition of actinomycin D; the second portion was irradiated without the addition of the antibiotic; the third portion contained actinomycin D but was not irradiated. Results are shown by means of graphs. The radioinduced degradation of DNA was greatly increased by the presence of actinomycin D at lower doses. With increasing doses the enhancement diminished. Possible interpretations of the synergistic effects of actinomycin D are presented. The action of actinomycin D in potentiating radiation effects in mammalian cells may well be concerned with the potentiation of radioinduced DNA degradation. (H.L.W.)

40592 EARLY EFFECTS OF CANCER THERAPY ON UPTAKE OF ^{131}Cs BY TUMOR: CORRELATION WITH CLINICAL RESULT. Ferguson, Donald J.; Harper, Paul V. (Univ. of Chicago). Surg. Clin. N. Amer., 47: 1507-15 (Dec. 1967).

The uptake of ^{131}Cs in surgically removed normal human tissues from various organs, in mouse and canine tissues, and in surgical specimens of benign and malignant tumors before and after radiotherapy is reported. The uptake of ^{131}Cs by metastases on the surface of the body was observed during the first few days of treatment. The predictive value of the changes in uptake was then determined by correlating it with the eventual outcome of the full course of treatment. There apparently was some correlation between an initial change in uptake ratio of ^{131}Cs in metastases and later responses to treatment. There was a definite predictive value in marked decrease or some increase of ^{131}Cs uptake ratios during the first few days of treatment. Where there was no regression of tumors in which uptake of ^{131}Cs was measured, lack of progression of these tumors for seven and ten months may have been significant; it was accompanied by regression of other tumors and by a satisfactory clinical result. (BBB)

40593 STUDY AFTER X IRRADIATION OF THE TRUNK OF GOATS. Steinbach, Irmhild. Strahlentherapie, 135: 69-75 (1968). (In German).

Clinical-pathological changes occurring after x irradiation of the trunk of goats were investigated. Four goats each received four different radiation doses, ranging from sublethal to lethal. An erythropenia was observed two or three weeks after irradiation for several weeks, depending on the dose. The rapid decrease in leukocytes was also dose-dependent. The number of thrombocytes decreased two weeks after irradiation, reached a low in the third week, and was followed by a rapid increase. A dose dependency was observed only so far as goats irradiated with 900 R showed the greatest decrease in thrombocytes two and eight weeks after irradiation. The changes in bilirubin after irradiation followed an undulating course. A sharp increase in the bilirubin content was observed in the goats irradiated with lethal doses, but a dose dependent reaction could not be found in the surviving goats. A decrease in hemoglobin occurred in the surviving goats between three and five weeks after irradiation; but a dose dependency was not observed. A significant increase in hemoglobin was found in the lethally irradiated goats. The alkaline phosphatase activity decreased after irradiation in all animals. (auth)

40594 EFFECT OF X-IRRADIATION ON MYOSIN-ATPASE IN THE PRESENCE OF HISTIDINE. Ueno, Akiko; Akita, Yasukazu (Tokyo Univ.). J. Radiat. Res., 8: 80-91 (June 1967).

Effects of x-irradiation on myosin-ATPase were studied. It was found that on x-irradiation, ATPase activity of myosin was markedly increased, if a certain amount of histidine was present in the solution. It was also found that when an aqueous solution of histidine was first irradiated with x-rays and then this irradiated histidine added to a myosin solution, an equally marked activation of myosin ATPase was produced. These results seem to indicate that some kinds of activating agent for myosin-ATPase was formed from histidine on irradiation. Irradiated histamine and imidazol were also found to be effective in producing a marked activation of ATPase when these were added to myosin solutions. However, when myosin solutions that contained either histamine or imidazol were irradiated, ATPase activity of these solutions was not so high as that observed when a myosin solution, containing histidine, was irradiated. Possible mechanisms involved in the activation of myosin-ATPase by x-irradiation in the presence of histidine have been discussed. (auth)

40595 HYDROLYTIC ENZYME ACTIVITY IN RAT SMALL INTESTINE AFTER WHOLE-BODY IRRADIATION. Wrigglesworth, J. M.; Pover, W. F. R. (Univ. of Birmingham, Eng.). Int. J. Radiat. Biol., 12: 243-50 (1967).

The levels of DNA, protein and a number of enzymes were measured in the small intestine of rats after exposure to 1000 rads whole-body x irradiation. The measurements were made on mucosal homogenates 12, 24, 36, 48 and 72 hours after the irradiation. After 12 hours the total organ content of DNA, protein, succinic dehydrogenase and glucose-6-phosphatase fell below control levels and continued to fall up to the third day. In contrast, the total organ levels of four acid hydrolases and two alkaline hydrolases were increased in value in the first 36 hours, and the specific activity of the acid hydrolases remained higher than control levels up to the third day. Changes in the morphology of the small intestine after irradiation were followed using histological preparations. The results showed that catabolic processes in the epithelial layer of the small intestine could play an important part in intestinal degeneration after irradiation. (auth)

40596 EFFECT OF DRUG THERAPY ON THE UPTAKE OF RADIOACTIVE FLUORINE BY OSSEOUS METASTASES. Kampffmeyer, Hermann G.; Dworkin, Howard; Carr, Edward A. Jr.; Bull, Frances E. (Univ. of Michigan, Ann Arbor). Clin. Pharmacol. Ther., 8: 647-57 (Sept.-Oct. 1967).

The effect of therapy on the uptake of ^{18}F by bone metastases was studied in eight patients. The short physical half-life of 110 min of ^{18}F permits administration of a dose of 1 mCi, with recording of a relatively high count rate shortly after administration and a relatively low irradiation dose to the patient. The techniques used were the scintigram and the quantitative uptake. The fact that scintigrams have often been shown to reveal metastases before x-ray films suggests the possibility that changes in osseous metastases caused by therapy might also be detectable by radioisotopic techniques before other evidence of the change becomes available. (BBB)

40597 EFFECT OF TEMPERATURE ON THE RADIAL EXCHANGE OF LABELED WATER IN MAIZE ROOTS. House, C. R. (Royal Dick Veterinary Coll., Edinburgh); Jarvis, P. J. Exp. Bot., 19: 31-40 (Feb. 1968).

The temperature dependence of the efflux kinetics of ^3H_2O in isolated Zea mays roots was studied. The excised roots were placed in ^3H_2O saline solution with a specific activity of 100 μCi/ml for an equilibration period of 1 hr at 25°C. The energy of activation, ΔE (Kcal/mole), of the rate-limiting step in the radial exchange process was calculated for various experimental conditions. Estimates of ΔE were obtained from linear relations between $\ln\{D_w\}$ and the reciprocal of the absolute temperature; values of the apparent diffusion coefficient, D'_w, of ^3H_2O in the root were found from an analytical treatment of the efflux data in terms of a cylindrical diffusion model. The energy of activation for ^3H_2O exchange in normal roots was 14.9 Kcal/mole. The corresponding value for dead (boiled) roots was 3.9 Kcal/mole. These values of ΔE indicated that in normal roots the penetration of water across the membranes of the root cells constituted the rate-determining step in the efflux whereas in dead roots extracellular diffusion of water was the source of rate-control. Studies of the efflux kinetics of ^3H_2O from normal and dead roots treated with 10^{-5} M phenylmercuric acetate indicated with this inhibitor produced an alteration in some structural aspect of rate-controlling membranes. (BBB)

40598 DNA DEGRADATION IN ESCHERICHIA COLI 15T⁻L-INDUCED BY FAST PROTON IRRADIATION. Huston, Douglas Courtland. University Park, Pa., Pennsylvania State Univ., 1966. 59p.

Thesis.

Cells of Escherichia coli 15T⁻L⁻, previously labeled with ^{14}C-thymine, were irradiated with fast protons from a Van de Graaff accelerator. The cells were then held in growth medium for up to two hours and periodically one milliliter of culture was mixed with one milliliter of cold 10% trichloroacetic acid (TCA). The subsequent precipitate (the acid insoluble fraction) was collected on a filter and the ^{14}C-label it contained determined by radioactivity measurements. The degradation of DNA was seen as a loss of ^{14}C-label from the cold TCA insoluble fraction. The process of radiolysis of DNA was seen to be in two phases. The first process occurred at a rapid rate immediately after irradiation. The kinetics were unusual and the process did not persist at incubation temperatures above 40°C. This rapid degradation process was not observed in cells that were not actively synthesizing DNA. The second process was not apparent until several minutes after irra-

diation and proceeded at a slow rate. Normal enzyme kinetics were observed for this process over a wide range of temperatures. The slow degradation process was observed in cells not actively synthesizing DNA but was not observed in cultures that were incubated at 70°C for ten minutes prior to irradiation. Altered function of the DNA polymerase brought about by radioinduced lesions in the DNA was suggested as a possible model of fast component DNA degradation. The slow component appeared to be the result of DNAase activity brought about by a breakdown in normal intracellular processes induced by heavy doses of fast proton irradiation. (Disser. Abstr.)

40599 RADIATION COPOLYMERIZATION OF UNSATURATED POLYESTERS WITH MONOMERS. Omeltschenko, Svetlana Ivanovna; Videnina, Nelli Grigorevna; Kabakchi, A. M.; Tschervetzova, Inna Nikolaevna; Schtschepetkina, Nina Ivanovna; Pyankov, G. N.; Morosov, A. V. (Inst. for Chemistry of High-Molecular Compounds, Physical Chemistry, and Mechanics, Kiev). Plaste Kaut., No. 11, 793-5(1967). (In Russian).

Poly(diethylene glycol) maleate-phthalate, poly(ethylene glycol) maleate-endomethylenetetrahydrophthalate, poly(ethylene glycol) maleate-adipate, and poly(ethylene glycol) maleate-sebacate were copolymerized with styrene, vinyl acetate, methyl methacrylate, and triallyl cyanurate under the effect of 190–2060 rad/sec γ-rays from Co-60 at 20 C, using a peroxide-type initiator. Copolymerization rate and conversion were significantly affected by the radiation dose: maximum copolymerization was evident at 2 Mrad in polyesters with aliphatic chain. Maximum copolymer strength and hardness were evident at the same dose in all copolymers. The nature of the monomer also affected the copolymerization and conversion. The monomers ranked as follows, in order of decreasing activity: vinyl acetate, styrene, triallyl cyanurate, methyl methacrylate. Copolymers with triallyl cyanurate had the highest gel-fraction content; those with methyl methacrylate, the lowest. Maximum compression strength was evident in copolymers with low-activity monomers at 20 Mrad. Generally, the copolymers were relatively hard, strong, heat-resistant, water-resistant, and resistant to organic solvents, inorganic acids, and alkalies. Orig. art. has: 3 figures and 3 tables. (JPRS)

40600 THE CONCENTRATION OF IODIDE, PERTECHNETATE, AND BROMIDE IN HUMAN SALIVA AND GASTRIC JUICE. Alexander, W. D.; Harden, R. McG.; Shimmins, J. (Western Infirmary, Glasgow). J. Physiol. (London), 194: 89P-90P(Feb. 1968).

The peroxyanion, pertechnetate (TcO_4^-) is similar to iodide in field strength, ion exchange properties, and ionic size and is concentrated in the thyroid in man, but not organically bound at early time intervals. It has been suggested that $^{99m}TcO_4$ may prove useful as a tracer in studies of the thyroid trap. Saliva provides a useful system in which to study the iodide trap in isolation. The uptake of radioisotope has been measured quantitatively using the saliva/plasma (S/P) and gastric juice/plasma (GJ/P) ratios and the saliva and gastric juice clearance. Simultaneous ^{132}I, $^{99m}TcO_4$, and ^{82}Br S/P and GJ/P ratios and salivary and gastric clearances were measured in normal volunteers. The concentration of the ions was in both gastric juice and saliva in the order $^{132}I^- > {}^{99m}TcO_4^- > {}^{82}Br^-$ The GJ/P $^{132}I^-$ and GJ/P $^{99m}TcO_4^-$ ratios were less than the corresponding ratios in saliva. In contrast, $^{82}Br^-$ was found to be more concentrated in gastric juice than in saliva. The ratio of $^{132}I^-$ to $^{99m}TcO_4^-$ clearance was greater in gastric juice than in saliva. In an additional group of patients the $^{132}I^-/{}^{99m}TcO_4^-$ clearance ratio was found to remain constant in saliva with increasing flow rate, whereas the ratio in gastric juice fell. It is concluded therefore that in the stomach, although $^{99m}TcO_4^-$ and $^{82}Br^-$ may share with $^{132}I^-$ one transport mechanism, they are also transported by a mechanism not common to $^{132}I^-$. (BBB)

40601 COMPLETE LABELING OF ALL CELL NUCLEI IN NEWBORN RATS WITH ^{3}H-THYMIDINE: A TOOL FOR THE EVALUATION OF RAPIDLY AND SLOWLY PROLIFERATING CELL SYSTEMS. Fliedner, Theodor M.; Haas, Rainer J.; Stehle, Hildegard; Adams, Angela (Institut fuer Haematologie, Freiburg, Ger.). Lab. Invest., 18: 249-59(Mar. 1968).

A method for labeling all cells of the fetus is described, and genetic and somatic effects of the incorporated radioactivity were studied. Pregnant rats received ^{3}H-thymidine at a dose level of 0.4 μCi/g of body weight every six hr from day nine of pregnancy until delivery of the offspring. Autoradiographic evaluation of the tissues and organs of the newborn animals indicated that all cells were heavily labeled. Systems with a slow turnover in the adult retained the label for many weeks after birth, while rapidly proliferating systems lost their label within a few days. Growth curves, weight curves, erythrocyte and leukocyte changes, chromosomal analysis, and bone marrow differential counts were evaluated for evidence of radiotoxicity. Some retardation in growth of the labeled rats became manifest by ten days after birth. Malformations were not observed in any newborn rats, labeled or unlabeled. There was no increase in abnormal cells of any type in the bone marrow of labeled animals as compared to the unlabeled controls, nor were there any chromosomal abnormalities. Although some radiation effect could not be excluded, it was very small and not further demonstrable some weeks after birth. (BBB)

40602 RADIATION DOSE RECEIVED BY INHALATION OF AIR CONTAINING ^{222}Rn, ^{220}Rn, ^{212}Pb (ThB), AND THEIR DECAY PRODUCTS. Pohl, E.; Pohl-Rueling, J. (Univ. of Innsbruck. Research Inst. of Badgastein, Austria). An. Acad. Brasil. Cienc., 39: 393-404(Dec. 31, 1967).

Inhalation of air containing Rn or Tn resulted in airborne solid decay products being filtered off into the respiratory tract. From there, the decay products were partly resolved into the bloodstream and then conveyed to all other organs. The distribution of these decay products in various organs of the guinea pig is given. The radiation dose to man following inhalation of air containing Rn, Tn, or ThB (^{212}Pb) was estimated. (auth)

40603 STUDIES ON LETHAL EFFECT OF RADIATION ON CULTURED MAMMALIAN CELLS. Terasima, Toyozo (National Inst. of Radiological Sciences, Chiba, Japan). Acta Pathol. Jap., 17: 342-4(Aug. 1967).

By use of a method for synchronizing mammalian cells, a fluctuation in radiosensitivity was demonstrated during the growth cycle of HeLa cells, providing a clue for investigation of the sensitivity of cells in relation to the DNA synthesis cycle. The slope of survival curves of cells at various stages during the cycle underwent cyclical change: maximal values for mitotic (M) cells (dose = 70 R) and mid-interphase cells (100 R), and minimal values for postmitotic (G1) cells (180 R) and post-synthetic (F2) cells (160 R). Dose survival levels were examined as a measure of radiosensitivity to analyze a possible correlation to the DNA cycle. The DNA-synthetic period (S) was shown to be in the middle of the cycle by plotting the fraction of labeled cells as measured by ^{3}H-thymidine autoradiography. When specific DNA inhibitors such as fluorodeoxyuridine and hydroxyurea were introduced at the G1 period, survival was gradually diminished until the block was released. This sensitization was interpreted as an accumulation of late G1 cells which was responsible for the peak sensitivity observed. To investigate a possible involvement of DNA synthesis in radiation lethality, synchronized cultures were irradiated in the late G1 and in the S period, followed by the determination of the rate of DNA synthesis. Synthesis was found to be depressed in irradiated S cells, whereas no decrease was detected in cells irradiated at the late G1 period which would be expected to give the lowest survival. This finding does not seem to reconcile with the view that damage to DNA synthesis was responsible for the cell killing by radiation, although much evidence has been accumulated demonstrating the high susceptibility of DNA synthesis in various kinds of mammalian tissues and cells to lethal or sublethal doses of x rays. (BBB)

40604 FEATURES OF BRAIN BIOELECTRIC ACTIVITY OF ANIMALS IRRADIATED DURING THE ANTENATAL PERIOD BY IONIZING RADIATION. Piontkovskii, I. A. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Zh. Vyssh. Nerv. Deyateln. Im. I. P. Pavlova, 14: 1019-28(Nov.-Dec. 1964). (In Russian).

Bioelectrical activity of the brain was studied in rabbits and rats γ irradiated in utero. The irradiation was performed on the 12th day of embryogenesis on rats at doses of 25 to 200 R and on the 15th or 23rd day on rabbits at doses of 300 to 400R. The spontaneous EEG of the irradiated animals exhibited reduced potential magnitudes and a more pronounced spindle-like activity. At the same time, excitability, reactivity, and motility were reduced. The shifts of EEG frequency spectrum and peculiarities of photic response depended on the time of the irradiation. When the irradiation trauma was caused during organogenesis, high frequencies were more pronounced; when the irradiation trauma was caused in the fetal period, low frequencies were prevalent. Adrenaline tests show enhanced sensitivity, particularly in animals irradiated during organogenesis. (BBB)

40605 SYNCHRONIZED YEAST CELLS. 3. DNA SYNTHESIS AND DNA POLYMERASE AFTER INHIBITION OF CELL DIVISION BY X RAYS. Eckstein, H.; Paduch, V.; Hilz, H. (Univ., Hamburg). Eur. J. Biochem., 3: 224-31(Dec. 1967).

X irradiation (50 KR) of synchronized yeast cells (Saccharomyces cerevisiae) in the G_1 phase destroys the proliferating ability of most cells without affecting metabolism to a comparable extent, the synthesis of many cell components proceeding nearly normally. The most pronounced alteration concerns the increase in DNA content. The first doubling of DNA in the irradiated cells is strongly retarded, but finally DNA rises again leading to a DNA content at least 5 times the normal values. An

analysis was made of the behavior of DNA polymerase under these conditions. Extracts from synchronized yeast cells exhibited a fluctuating DNA polymerase activity during the cell cycle, with maximum activity just before the onset of DNA replication. Degradation and resynthesis, or transformation to an inactive zymogen, are considered as possible mechanisms of the oscillating behavior of polymerase activity. X irradiation caused dissociation of DNA replication and fluctuating appearance of the polymerase. Whereas DNA replication was temporarily delayed, the rhythmic appearance of the enzyme was unaffected. However, the height of the activity maxima remained unchanged until DNA was reduplicated again. The observations are discussed with regard to the apparent intactness of the DNA template functions and to the persistence of the sequential transcription of genes in the proliferation-inhibited irradiated yeast cells. (BBB)

40606 ASSIMILATION AND DISTRIBUTION OF ^{89}Sr IN APPLE TREES. Kavteladze, B. M.; Osei, Yu. P. Soobshch. Akad. Nauk Gruz. SSR, 50: No. 1, 185-90(Apr. 1968). (In Georgian).

The comparative uptake and distribution of ^{89}Sr through wood, sound bark, and soil by the apple sapling of the Shampanskii renet variety were studied. In the first test, strontium nitrate solution with an activity of 100 μc/15 ml was innoculated directly into the wood. In the second test ^{89}Sr in solution of the same activity was applied to the trunk of the tree at heights of 10 cm from the ground. In the third test ^{89}Sr with a total activity of 1100 μc was introduced into the soil. The results showed that in all cases ^{89}Sr was assimilated by the plant. The distribution of the strontium had a damaging character. The concentration of Sr was higher in the lower part of the apple tree than in the upper part. The transfer of the strontium proceeded in a basipetal and radial direction. The rate of the ^{89}Sr transport after innoculation through the wood was approximately 10 cm/hr. At the end of the tests, the strontium had accumulated principally in the roots, then in the bark, and then the wood. The content of strontium in the seeds exceeded that in the apple pulp. (tr-auth)

40607 SULFATE AND IODIDE CONCENTRATION IN BRAIN. THE INFLUENCE OF CEREBROSPINAL FLUID. Cutler, R. W. P.; Lorenzo, A. V.; Barlow, C. F. (Harvard Medical School, Boston). Arch. Neurol., 18: 316-23(Mar. 1968).

The brain-plasma steady-state ratio for ^{35}S and ^{125}I after intravenous injection of $Na_2{}^{35}SO_4$ and $Na^{125}I$ is 2% to 4%. The cerebrospinal fluid (CFS)-plasma ratios under these circumstances are 7% and 1% respectively. The low CSF concentration of these anions may provide a sink for the brain extracellular space. Following combined intravenous injection and prolonged ventriculocisternal perfusion of these solutes in tracer amounts, to achieve equivalent levels in plasma and CSF, the brain-plasma ratios increased 3- to 4-fold in areas well-bathed by perfusate. The results indicate that the steady-state level of certain solutes in the brain is dependent in part upon the concentration in CSF. (BBB)

40608 UPTAKE OF STRONTIUM BY HIGHER PLANTS IN MIXED CULTURES. Laeuchli, Andre (Univ., Basel). Ber. Schweiz. Bot. Ges., 76: 239-46(1966). (In German).

The uptake of strontium by single and mixed cultures of Zea Mays and Pisum sativum was investigated. There were no differences between the two culture conditions for maize, but the uptake by Pisum was higher in mixed than in single cultures. This increased uptake of strontium comes from the change of pH in the culture solution from pH 4.1 to about pH 6.5. No similar influence of pH was found for maize. The results represented a case of ion competition between higher plants. (auth)

40609 METABOLIC FRACTIONATION OF CARBON ISOTOPES IN MARINE PLANKTON. II. DATA ON SAMPLES COLLECTED OFF THE COASTS OF PERU AND ECUADOR. Degens, E. T.; Behrendt, M.; Gotthardt, B.; Reppmann, E. (Woods Hole Oceanographic Inst., Mass.). Deep-Sea Res., 15: 11-20(Feb. 1968).

Marine plankton, collected off the coasts of Peru and Ecuador in the spring of 1966 during the Anton Bruun Cruise 15, was examined for the carbon isotope composition of its major biochemical constituents. Relative to sea water bicarbonate, the hemicellulose, proteins, and pectins were enriched in ^{12}C by about 17‰. The ^{12}C enrichment for cellulose and lignin amounted to 23‰, and the corresponding value for the $CHCl_3$-extractable lipid fraction was 30‰. Besides its biological significance in studies on the pathway of carbon during photosynthesis, this observation was of geochemical interest in work concerned with the diagenesis of organic matter in sediments. It was evident that the geochemically more stable organic fractions of marine plankton, i.e., cellulose, lignin, and fat, were significantly enriched in ^{12}C, and to about the same extent as terrestrial organic detritus. The observed enrichment of ^{12}C was explained as a result of the diagenetic elimination of the easily perishable ^{13}C richer carbohydrate-protein fraction from the marine sediment. (BBB)

40610 KINETIC ANALYSIS OF ISOTOPE EXCHANGE FROM A CYLINDER. Cho, Chai Moo (Veterans Administration Hospital, Hines, Ill.); Greco, Joseph; Talso, Peter J.; Kaplan, Ervin. J. Theoret. Biol., 16: 151-8(Aug. 1967).

Isotopic exchange phenomena between a sample confined in a cylindrical container and a completely mixed solution of infinite size were analyzed. Fick's second law was used for the analysis of the transport of the labeled species from the cylindrical cell to the external solution. The model chosen for the analysis was that of two composite cylinders with different diffusion coefficients. Two cases were analyzed, where no mixing existed, and where complete mixing of the sample took place during the isotopic exchange. The analysis showed that the ratios of the diffusion coefficients and the thickness of the solution and membrane contribute to the number of observable exponential terms when the isotope remaining in the cylinder is plotted against time. (BBB)

40611 KINETIC ANALYSIS OF ISOTOPE EXCHANGE FROM A CYLINDER CONTAINING DISSOCIABLE NON-PERMEABLE INTERACTING SUBSTANCE. Cho, Chai Moo (Veterans Administration Hospital, Hines, Ill.); Greco, Joseph; Talso, Peter J.; Kaplan, Ervin J. Theor. Biol., 16: 159-65(Aug. 1967).

A kinetic analysis was determined of an isotopic exchange between a cylinder containing nonpermeable interacting substance and an infinitely large sink. Fick's second law of diffusion coupled with reversible first-order reaction was used for the analysis. The analysis was made in two conditions, one without mixing and the other with complete mixing of the sample in the cylinder. The equations expressing the amount of radioisotope remaining in the cylinder were derived as a function of time. These showed that the appearance of the multi-exponential curves occurred whenever the chemical reaction rate constant was close to or smaller than the diffusion constant. If the reaction rate constant was very large, the overall rate of decrease in the isotope in the cylinder was expressed as straight diffusion from a cylinder. The observable rate constant in the latter case was a function of the ratio of isotope between free and bound phases. The equation can be used experimentally to determine the ratio of the isotope in the bound and free phases of the sample if the membrane is a truly rate-determining step of the isotopic exchange. (BBB)

40612 RANNIYE RADIATSIONNO-BIOKHIMICHESKIYE REAKTSII. (Early Radiation and Biochemical Reactions). Romantsev, Evgenii Fedorovich; Blokhina, Vera Dmitrievna; Koshcheenko, Nikola Nikolaevich; Filippovich, Igor' Vladimorovich. Moscow, Atomizdat, 1966. 270p.

The nature of early biochemical changes in the living cell following irradiation, and the effect of protective chemicals used in counteracting radiation in the living organism are reviewed. The formation of peroxides and peroxide-like compounds, the effect of radiation on the synthesis of DNA and information RNA, the formation of macroergs, and other radiation problems in radiation biochemistry are discussed. An attempt is also made to determine the relation between the operational mechanism of several protective chemicals and radiosensitive biochemical reactions. Each chapter is accompanied by an extensive list of references. This book is intended for biologists and biochemists concerned with problems of radiation biochemistry. (auth)

40613 SULFUR ISOTOPE FRACTIONATION AND KINETIC STUDIES OF SULFITE REDUCTION IN GROWING CELLS OF SALMONELLA HEIDELBERG. Krouse, H. R.; McCready, R. G. L.; Husain, S. A.; Campbell, J. N. (Univ. of Alberta, Edmonton). Biophys. J., 8: 109-24(Jan. 1968).

Several species of Salmonella are capable of significantly altering the $^{34}S/^{32}S$ abundance ratio during $SO_3^=$ reduction to H_2S. The attending isotope effects are much larger than those associated with the inorganic chemical reduction of $SO_3^=$. A pulsed feeding technique was used during studies of sulfite reduction by S. heidelberg to realize large percentages or $SO_3^=$ conversion while simultaneously maintaining a reasonably stable cell population. As a consequence, many data for conventional kinetic and S isotope fractionation computations were obtained in any one experiment. Under the conditions of supplying 150 μg glucose per ml of medium every 6 hr, anaerobiosis, and varying the $SO_3^=$ concentration, it was found that below 0.01% W/V Na_2SO_3, the reduction strictly followed first-order kinetics with respect to $SO_3^=$ concentration. At higher concentrations, the rate of $SO_3^=$ reduction fell below that predicted by first-order kinetics suggesting that a saturation effect was occurring. At lower Na_2SO_3 concentrations, the ratio of the isotopic rate constants k_1/k_2 was 1.02 whereas at higher $SO_3^=$ levels, k_1/k_2 values of 1.04 were found, effects much higher than those obtained in the equivalent chemical reduction. A model is considered which features two isotopically

dependent steps and an intermediate reservoir that forms at higher $SO_3^{=}$ concentrations. (BBB)

Ecology

Refer also to abstracts 40688 and 40832.

40614 (RLO-2047-2) COLUMBIA RIVER STUDIES. Annual Report, 1967-68. Seymour, Allyn H. (Washington Univ., Seattle. Lab. of Radiation Ecology). June 26, 1968. Contract AT(45-1)-2047. 16p. Dep. CFSTI.

Investigations were conducted on the distribution of stable- and radiophosphorus in the marine environment at one locality near the mouth of the Columbia River. A study was undertaken on the sensitivity of oyster larvae to ^{65}Zn, ^{51}Cr, and ^{90}Sr. A study was undertaken on the distribution of ^{65}Zn in mussels from the mouth of the Columbia River northward along the Washington coast, then eastward along the Straits of Juan de Fuca, and southward into Puget Sound to determine the feasibility of the use of this radionuclide and organism as a biological monitor of Columbia River water. The measurement of ^{65}Zn in benthic organisms from the Straits of Juan de Fuca was undertaken in addition to the measurements of ^{65}Zn in mussels, an intertidal zone organism, to further explore the relationship of ^{65}Zn in organisms to the distribution of Columbia River water. Data are tabulated for ^{65}Zn and ^{40}K in mussels from the Columbia River, Washington Coast, the Straits of Juan de Fuca, and Puget Sound and ^{65}Zn in fish and sea urchins from the Straits of Juan de Fuca. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 40552, 40559, 40772, 40778, 40793, 40855, 40910, 40952 40970, 40972, 40973, and 40975.

40615 (EUR-3889) MOLECULAR AND RADIATION GENETICS. Annual Report, 1966. (Leiden Rijksuniversiteit (Netherlands)). Dec. 11, 1967. 28p. Dep.

A general report is given of investigations covering in vitro induction of protein synthesis in general and the synthesis of immune antibodies in particular and the effect of radiation thereon; relation between structure and function of the DNA of viruses and the effects of radiation modification; genetics of microorganisms and the effects of radiation upon these; the effect of ionizing radiation on DNA; studies of the physical, chemical and biochemical factors affecting radiation-induced mutation frequencies in Drosophila; the effect of ultraviolet and ionizing radiation on gene function, genetic recombination and replication of bacteriophage DNA; and studies on regulatory mechanisms of somatic cells in vitro. (auth)

40616 (NYO-1979-26) QUANTITATIVE POPULATION GENETICS OF MICE UNDER IRRADIATION. Period Covered: June 1, 1965-May 31, 1968. Green, Earl L.; Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). June 30, 1968. Contract AT(30-1)-1979. 17p. Dep. CFSTI.

Nonirradiated descendants of irradiated and nonirradiated randombred sublines of populations of mice were compared with respect to lifespan and body weight. Mature body weight decreased significantly with increased exposure to radiation; no effect was found on lifespan. Nonirradiated descendants of irradiated and nonirradiated sublines of two populations of mice were compared with respect to lifetime reproductive performances, including percentages of fertile matings, mean numbers of litters, mean litter sizes, percentages of survival between birth and weaning, mean total numbers of progeny, and mean numbers of days of reproductive life. Results indicated that there were no differences in reproductive fitness between the matings of nonirradiated descendants of the control and various irradiated sublines. Experiments on accumulated genetic exposure to x radiation indicated that there was no apparent effect on embryonic mortality rate nor on the fetal abnormality rate. The RX-ML and DX-ML populations were carried through 16 generations of spermatogonial irradiation. A smaller number of animals was born in the higher dose groups and a smaller litter size was found in some lines. Other experiments were conducted to study recessive visibles, lethals, heritability, and inbreeding coefficients. Studies on genetics of radiation resistance in mice revealed a high incidence of lymphatic leukemia on one line. Studies on repopulation of the germinal epithelium following a heavy dose of radiation indicated that repopulation was accomplished by cells in the testis itself. Studies on genetic variants included determination of effects of deleterious recessives in heterozygotes of natural and radioinduced mutations and biochemical polymorphisms. (H.L.W.)

40617 (NYO-3096-26) PROGRESS REPORT [ON GENETIC STUDIES] FOR JUNE 1, 1967-MAY 31, 1968 AND A REVIEW OF THE WORK FOR JUNE 1965-MAY 1968. Dobzhansky, Theodosius (Rockefeller Univ., New York). Contract AT(30-1)-3096. 29p. Dep. CFSTI.

Progress is reported on elucidation of the basic problems of the genetic structure of natural populations as approached by investigation of so-called genetic loads in natural populations of Drosophila sp.; genetic and environmental determinants of population size; genetic architecture of behavioral traits of populations of this insect; and secular changes in the genetic composition of populations of Drosophila pseudoobscura in the western United States. (B.S.L.)

40618 (ORO-1747-14) RADIATION GENETICS AND RADIATION RESISTANCE IN PEANUTS. Progress Report, July 1, 1967-June 30, 1968. (North Carolina State Univ., Raleigh). July 1968. Contract AT(40-1)-1747. 30p. Dep. CFSTI.

Nine independently mutated phenotypes were crossed to nine A-Control tester families and analyses of variance were conducted. Data are tabulated for: fruit yield, fruit length, fruit weight per standard volume within A and B Control families; fruit yield per 50 seed plot in pounds among different crosses; fruit length per 20 two-seeded fruit in cm.; means, ranges, and variances for fruit yield of F_4 hybrid progenies; means, ranges and variances for fruit weight per standard volume of F_4 hybrid progenies; comparisons of progeny variances for fruit yield, length, and weight per standard volume among single and randomly drawn families for each mutant. Field experiments were based on two blocks of approximately 450 plants each, one consisting of embryos of 65 outcrosses without irradiation, and the other of embryos treated with 10 KR of x rays at a rate of 541 R per min. Irradiated seeds failed to germinate. (H.L.W.)

40619 (RT/BIO-(68)20) FIRST-YEAR RESULTS IN THE FAO/IAEA NEAR EAST UNIFORM REGIONAL TRIALS OF RADIO-INDUCED DURUM WHEAT MUTANTS. Tessi, J.; Scarascia Mugnozza, G. T.; Sigurbjoernsson, B.; Bagnara, D. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 25p. Dep.

Twelve varieties of wheat were treated with fast neutrons, thermal neutrons, and x rays. Results are presented in the form of histograms showing yields of mutant lines and varieties at various locations. Data are tabulated for yield, volume weight, plant height, lodging indices, heading date, and maturity date. It was concluded that in typical areas for durum wheat in North Africa, the Middle East, and in the Mediterranean Region early and lodging-resistant types are required. (H.L.W.)

40620 THE EVOLUTION, FROM METAPHASE TO ANAPHASE, OF CHROMOSOME ABERRATIONS INDUCED BY IONIZING RADIATIONS. Moutschen, J. (Univ., Liege). Med. Nucl. Radiobiol. Lat., 10: 289-303(1967). (In French).

To correlate the chromosomal aberrations observed at meta- and anaphase, Nigella damascena L. seeds were irradiated with γ rays from a ^{137}Cs source. The mechanisms by which chromosome aberrations can be selected out from metaphase to anaphase were studied. The role of fragment size was especially emphasized as well as the statistically exceptional length of the inter-segment of dicentrics (between both centromeres). It was postulated that in Nigella a high proportion of aberrations were preferentially localized at the end segments of chromosomes. Possible origin of this specificity is discussed. (auth)

40621 PROGRESS IN RADIATION SEED CULTIVATION. Hsu, Kuan-jen. Chung Kuo Nung Yeh K'o Hsueh, No. 12, 7-12 (Dec. 1961). (In Chinese).

Radiation seed cultivation has such characteristics as high mutation rate, large mutation range, breaking of heredity, inducing of xenogenesis, change of conceiving characteristics, producing of polyploids, improving of haploids, promoting of remote hybridization, and creating and altering secondary hereditary traits. The following are prerequisite for the quick stabilization of radiation mutations: reproductive capacity, capacity for reproduction of mutant cells, hereditarily stable mutations, and environment advantageous to survival of mutants. (JPRS)

40622 GENETIC RADIATION DAMAGE AND ITS REPAIR IN ESCHERICHIA COLI. Bridges, B. A.; Munson, R. J. (Medical Research Council, Harwell, Eng.). pp 95-188 of Current Topics in Radiation Research. Vol. IV. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1968.

The radiobiology of Escherichia coli is reviewed. Among the topics discussed are: The genetic apparatus of bacteria, lethal damage from uv and ionizing radiations and its repair, the hypothesis of types N and O damage, characteristics of uv and ionizing radiation mutagenesis, repair of premutational damage, interaction between uv and γ radiation, segregation and the concept of the mutable unit, mutagenesis by high LET particles, and the "strandedness" of newly induced mutations. Evidence is reviewed that confirms the hypothesis that the basic unreplicated genome is the

target for γ-radiation damage in E. coli and that attributes strain differences in γ-ray sensitivity to differences in repair abilities. Experiments on the effect of particles of different LET are interpreted as indicating that the chromatid is composed of two subtargets. Cases of radioinduced mutation are cited in which a positive identification of changes in DNA can be made. Techniques that distinguish true revertants and suppressor mutations such as the use of bacteriophage mutants with chain-terminating codons are described. Phenomena that are peculiar to uv mutagenesis are summarized. These include: increased frequency of mutations when induced in the frozen state, characteristic behavior of suppressor mutations, excision repair, and photoreversal of damage. 162 references. (M.M.B.)

40623 THE INDUCTION OF PIGMENTATION CHANGE IN A NON-ACID-FAST STRAIN OF MYCOBACTERIUM PHLEI BY ULTRAVIOLET RADIATION. Konicek, J.; Malek, I. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague), 12: 417-21 (1967).

Five scotochromogenic mutants and 11 achromogenic mutants of the non-acid-fast photochromogenic PN strain of M. phlei were induced by uv radiation. Spontaneous scotochromogenic and achromogenic mutants were not obtained. Colonies of the scotochromogenic mutants were orange except for one mutant which was ochre. Three mutants were resistant to streptomycin. Of the 11 achromogenic mutants, three were induced by uv treatment of the original photochromogenic strain and eight were prepared from the scotochromogenic mutant. No significant differences in the sensitivity to uv rays were found among the scotochromogenic mutant, achromogenic mutant and the photochromogenic PN strain of M. phlei under the given experimental conditions. Scotochromogenic mutants and most achromogenic mutants were stable and suitable for further genetic investigation. (BBB)

40624 MUTABILITY IN BOX-ELDER (ACER NEGUNDO L.) INDUCED BY GAMMA AND X RAYS. Privalov, G. F. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika, 4: No. 5, 39-42(May 1968). (In Russian).

Irradiation of box-elder seeds with equal doses of γ and x rays showed that these radiations differ in their deleterious effect on the seeds. Somatic cells were damaged by γ-rays more than by x rays. Critical doses of x rays and γ-rays for seeds were 20 kR and from 5 to 10 kR, respectively. Despite the wide difference in the deleterious effect of these radiations, their mutagenic efficiency was equal when the seeds were irradiated by x and γ rays at equal doses. These data suggest that there was no direct correlation between the radiosensitivity, estimated from the survival and germinating capacity of seeds, and the mutability of somatic cells estimated from the frequency of phenotypic changes. (auth)

40625 PRODUCTION OF PARTIAL DIPLOIDS IN THE BACTERIOPHAGE T4B AND THE STIMULATION OF THEIR FORMATION BY MEANS OF ULTRAVIOLET IRRADIATION. Matvienko, N. I.; Kriviskii, A. S. (Inst. of Molecular Biology, Moscow). Genetika, 4: No. 5, 113-18(May 1968). (In Russian).

In the progeny of the cross between the allellic deletional mutants (r1589 and r638) of the phage T4B, phages were detected whose genomes contained both these alleli simultaneously. The frequency of such partial diploids was 1.3×10^{-8}. This state of partial diploidy was transmitted to a considerable proportion of the progeny. The uv irradiation of Escherichia coli infected by both parental phages stimulated the formation of partial diploids. This stimulation was of the same order as the uv stimulation of the formation of r^+-recombinants in the cross between the mutants r1368 and r638. (auth)

40626 RADIATION EFFECTS ON MAN. I. EFFECTS ON GONADS AND GENETIC EFFECTS. Leonard, A. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). J. Belge Radiol., 51: 16-22(1968). (In French).

Each man is exposed during his whole life to some levels of natural and artificial radiation. While the cosmic ray intensities and the corresponding dose rates increase with altitude and latitude in some areas of high background radiation, the dose rate can reach 12,000 mrad/year. On the other hand there is an increasing use of ionizing radiations in medicine, science and industry. The observations have shown that the process of disappearance of the male germ cells and the regeneration of the seminiferous epithelium are similar in man and small mammals. However, the human testes appear to be more radiosensitive and the human ovaries more radioresistant than those from experimental mammals. Some variations in sex-ratio, an increase in embryonic lethality and a higher rate of malformations are the most obvious genetic effects of the radiations. (auth)

40627 EFFECT OF GAMMA RAYS ON HUMAN CHROMOSOMES. I. THE DEPENDENCE OF CHROMOSOME ABERRATION FREQUENCY UPON THE DOSE AT THE IRRADIATION IN VITRO. Sevan'kaev, A. V.; Bochkov, N. P. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, 4: No. 5, 130-7(May 1968). (In Russian).

Human lymphocytes were γ-irradiated in vitro at doses ranging from 25 to 400 R (at the dose rate 45 R/min). The frequencies of chromosome aberrations in the first postirradiation metaphases were studied. The aberrations recognizable without karyotypic analysis (dicentrics, rings, acentric fragments, and minutes) were counted. In the material studied an unequivocal distinction between usual acentrics and minutes was possible. Asymmetrical exchanges always resulted in one pair of fragments only, i.e., all chromosome exchanges were complete. The number of acentrics rose linearly with the dose only within the range 25 to 200 R. (auth)

40628 STUDIES ON RADIATION-SENSITIVE MUTANTS OF ESCHERICHIA COLI. I. MUTANTS DEFECTIVE IN THE REPAIR SYNTHESIS. Ogawa, Hideyuki; Shimada, Kazunori; Tomizawa, Jun-ichi (National Inst. of Health of Japan, Tokyo). Mol. Gen. Genet., 101: 227-44(1968).

Twenty-four uv sensitive strains that can not carry out the host cell reactivation and two that are deficient in recombination were isolated. By analyzing their properties and genetic locations, 21 uv sensitive strains were classified into the uvrA, B, and C groups and 3 strains into a group which has not been described. Two Rec^- strains were classified in the recA group. The uv sensitive mutants of the new group are distinctly different from other mutants in their properties and in the sites of mutation. We named this group the uvrD. These uvrD mutants have the following properties. They have an intermediate sensitivity against uv irradiation and a higher sensitivity against γ-ray irradiation than those of other uv sensitive mutants. The uv damages which are repaired in the participation of the uvrD gene are photoreactivable. In the cells uv irradiated λ phage rapidly loses the susceptibility to photoreactivation during the incubation in broth with chloramphenicol. The DNA of the uvrD mutant is rapidly degraded at a small dose of uv light and to a large extent. The uvrD gene locates very close to the metE gene and $uvrD^-$ is dominant over $uvrD^+$. The uvrD cells have the capacity to carry out uv reactivation for uv irradiated λ phage, in contrast to other uv sensitive mutants including the Rec^- ones which turned out to have no capacity. A double mutant, uvrB uvrD, is about three times as sensitive as the uvrB mutant against uv irradiation and DNA degradation after uv irradiation takes place at much lower rate than the uvrD mutant. These results show the presence of a functional relation between the uvrB and uvrD genes and suggest that the uvrD gene participate in the repair synthesis at a step following that performed by the uvrB gene. (auth)

40629 STUDIES ON RADIATION-SENSITIVE MUTANTS OF E. COLI. II. BREAKAGE AND REPAIR OF ULTRAVIOLET IRRADIATED INTRACELLULAR DNA OF PHAGE LAMBDA. Shimada, Kazunori; Ogawa, Hideyuki; Tomizawa, Jun-ichi (National Inst. of Health of Japan, Tokyo). Mol. Gen. Genet., 101: 245-56(1968).

It was shown that linear DNA molecules of phage λ are converted to the twisted circular structure (species I) by covalent closure of both strands at the cohesive ends after infection to the immune bacteria and that the twisted circular molecules are transformed to the circular form (species II) by a single-strand break in one of the strands of their DNA. For characterization of the defects of ultraviolet sensitive strains, the structural changes of ultraviolet irradiated λ DNA in these strains were studied. Ultraviolet irradiation of λ phage greatly reduced the extent of conversion of the molecules to the species I in the uvrD mutant while the irradiation showed little effect on the conversion in the uvrA, B and C mutants. When infected bacteria carrying species I molecules were irradiated, the species I molecules in the uvrD mutant were disrupted while most of the molecules in the uvrA, B and C mutants kept the structure. These results indicate that in the irradiated λ DNA strand breaks are rarely introduced or, if introduced, repaired rapidly in the uvrA, B and C mutants and they are introduced in the uvrD mutant leading to the degradation of the DNA. These results provide a firm evidence that the defect of the uvrD mutant is different from other Hcr^- mutants and in the process of repair synthesis. Ultraviolet irradiation to the uvrD mutants promotes the formation of the species I molecules from the infected irradiated λ-DNA. Such effect was not observed with the uvrA mutant. Since the uvrD mutant has uv reactivation capacity and the uvrA mutant has not, the above phenomenon is probably caused by uv reactivation and may provide a more direct method to study the mechanisms of uv reactivation than the plaque assay. (auth)

40630 RADIATION-INDUCED CHROMOSOMAL ABERRATION IN RELATION TO DNA SYNTHESIS. Yamamoto, Koji; Yamaguchi, Hikoyuki (Tokyo Univ.). J. Radiat. Res., 7: 115-22(Sept.-Dec. 1966).

Using autoradiographic technique with ^3H-TdR as a marker for DNA synthesis, the average duration of each phase of the mitotic

cycle in barley roots was estimated and was found to be as follows: G_1 (pre-DNA synthesis stage) 4.5 hrs., S (DNA synthesis stage) 4.5 hrs., G_2 (post-DNA synthesis stage) 4 hrs, and M (mitosis) 2 hrs. Autoradiographic studies also showed that an asynchronous replication of DNA occurred in barley chromosomes, terminal portions of the chromosome arms being first replicated. The examination of radiation-induced terminal deletions in anaphase cells revealed that chromosome sensitivity changed according to the stage of the cell cycle at which the cells were irradiated. The chromosome was more sensitive in late S and G_2 than in G_1, and the most sensitive in early S and/or late G_1. (auth)

40631 RADIOINDUCED CHROMOSOME ABERRATIONS. Leonard, A. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). J. Belge Radiol., 51: 23-8(1968). (In French).

Experiments performed in tissue culture with human material have shown that after irradation four types of cells are found: type A, without apparent abnormalities, type B with chromatid aberrations, type C with unstable chromosomal changes and type C with stable chromosomal changes. Using short term cultures of human peripheral leukocytes it was possible to make an estimation of the x ray dose received. It was established that chromosome aberrations can persist for many years in peripheral blood of persons irradiated for occupational or medical purposes or accidentally (32 references). (auth)

40632 X-RAY-INDUCED MITOTIC RECOMBINATION, GENE CONVERSION, AND MUTATION IN SACCHAROMYCES AND THE RADIOPROTECTIVE EFFECT OF CYSTEINE. Schwaier, R. (Univ., Freiburg i. B.). Mol. Gen. Genet., 101: 203-11(1968).

The x-ray-induced frequency of mutation, mitotic recombination and gene conversion was determined in Saccharomyces cerevisiae. X-rays induced only few mutations compared with alkylating nitrosamides but were highly efficient in the induction of mitotic recombination and gene conversion. Therefore, x rays in spite of their low mutagenicity turned out genetically to be a very harmful agent for diploid yeast cells. A protection against x-ray induced recombination and conversion could be achieved by the well known protecting agent cysteine. The protection factor is about 2. A similar effect could be observed with yeast extract-peptone medium but not with the amino acid serine. Furthermore, the protective effect of cysteine and yeast-extract peptone medium was studied at various concentrations and preincubation times. (auth)

40633 PHOTOREACTIVATION OF AN ULTRAVIOLET LIGHT INDUCED MUTATION IN MAIZE POLLEN. Matsumura, Seiji; Mabuchi, Tomoo (National Inst. of Genetics, Misima, Japan). Seiken Jiho, 18: 1-5(Dec. 1966).

Pollen grains were irradiated with either ultraviolet light (primarily 254 mh) at a dose rate of 90.3 ergs/mm^2/sec for 30, 60, and 90 sec or 550 and 1,100 R gamma rays from a ^{137}Cs 6,000 Ci source. Before being used to fertilize a recessive strain the pollen was post-treated for 30 min with either visible light (7,400 lux) from a 440 W high pressure mercury lamp or darkness. Seed endosperm characteristics were used to score mutants. Post-treatment didn't appear to affect the proportion of whole to chimeral mutants. The frequency of γ ray-induced mutations was unaffected by posttreatment. The frequency of ultraviolet-induced whole mutations was decreased by visible-light posttreatment, but not the frequency of ultraviolet-induced chimeras. (M.M.B.)

40634 COMPARISON OF MUTAGENIC EFFICIENCY BETWEEN ETHYL METHANESULFONATE AND IONIZING RADIATIONS IN DIPLOID WHEAT. Fujii, Taro; Matsumura, Seiji (National Inst. of Genetics, Misima, Japan). Seiken Jiho, 18: 23-31(Dec. 1966).

Mutagenic efficiencies of EMS, γ rays and 14 MeV neutrons were compared using Triticum monococcum flavescens. Both soaked and dried seeds were compared, and normal and heterozygotic F_1 seeds from a cross between normal and a chlorina mutant were used. Doses resulting in similar survival curves were compared and chlorophyll mutants were scored. Treatment with EMS (0.3%) resulted in a three times higher mutation frequency than 1.5 kR γ rays. Neutrons were about 15 times more efficient than γ rays. Treatment of wet seeds was about 10 times more effective than that of dry. (M.M.B.)

40635 GENETIC ANALYSIS OF A SUPPRESSOR GENE IN ANTIRRHINUM MAJUS L. Linnert, Gertrud (Technische Univ., Berlin). Mol. Gen. Genet., 101: 17-28(1968). (In German).

Abnormal segregation of the recessive character squamosa in the progeny of an x rayed pure line is due to the action of a specific suppressor and besides that a lethal factor, both linked to the squa-locus, the order being approximately squa-20%-let-24%-sup$_{squa}$. As a consequence in X_3 and X_4 squamosa-individuals sometimes produce about 25% normal plants, if the lethal is absent, and about 31%, if it is present, while normal individuals may produce about 25% squamosa or 31% respectively. By crossing over 9 genotypes may arise, each giving a specific segregation-ratio. As the original order of the genes in X_1 was established to have been Squa + s/squa let S, only squa may have originated by x radiation, while the suppressor sup$_{squa}$ is assumed to have been present in the untreated egg-cell. A combination of mutant genes closely linked to a lethal and a suppressor is liable to accumulate mutations and to store them in the heterozygous condition without being detected for some time. This model gives a good explanation for the specific mutation spectra formerly established in different sub-lines of Antirrhinum majus. As "Sippe 50" contains a series of suppressors and mutator genes as well, some attention should be directed to its RNA metabolism. (auth)

40636 CORRELATION BETWEEN REDUCED REPAIR CAPACITY FOR ULTRAVIOLET LESIONS AND HIGHER SPONTANEOUS MUTABILITY OF A MUTATOR STRAIN OF ESCHERICHIA COLI K-12. Mohn, Georges (Univ., Frankfurt am Main). Mol. Gen. Genet., 101: 43-50(1968). (In German).

The biauxotrophic strain of E. coli K-12 (λ), met 1/his 7, that exhibits an eight times higher rate of met 1 $\rightarrow$ met$^+$-backmutation as compared with the parent strain met 1, was found to be also more sensitive to uv irradiation. In addition, the maximum uv induction of prophage λ occurs at lower doses, and the capacity of the strain to propagate induced prophage is reduced. The mutant strain has also lost part of the ability to repair uv-induced lesions in phage T 1. The phenotypes high mutability and uv sensitivity could not be separated by means of recombination. From these findings it is concluded that part of the spontaneously occurring changes in DNA (premutations) that lead to met$^+$ genotype are similarly repaired as some uv induced ones, and that the mutator mum$^+$ of strain met 1/his 7 causes a reduced repair of both changes. (auth)

40637 INFLUENCE OF BROMOURACIL ON LOSS MUTATIONS AND INTERACTION OF UV AND X RADIATIONS IN PHAGES. Pohl, D.; Kaplan, R. W. (Univ., Frankfurt am Main). Biophysik, 4: 196-213(1968). (In German).

Bromouracil (BU) was incorporated into the DNA of the Serratiaphage $\varkappa$ by means of culture in a medium with BUdR and FUdR. The density of BU-x particles in the CsCl-gradient indicated a replacement of about 24 to 32% of the thymine by BU. The frequency of two types of plaquemutants (c and b) in the BU-$\varkappa$-population was increased significantly above the frequencies in BU-free phage by average factors of 1.4 and 2.4, respectively. A third mutant type (e) was increased less. The frequencies of additional c- and b-mutants in BU-$\varkappa$ compared with normal $\varkappa$ were about 2.10^{-4} and 1.10^{-4}, respectively. The uv-inactivation of BU-$\varkappa$ was higher by a factor of about 1.40 than that of normal $\varkappa$, the inactivation by x-rays was only 1.14 times higher. The x-ray induced plaquemutation frequencies were not remarkably influenced by incorporated BU, but uv-mutation-induction was increased much more than uv-inactivation. The sensitization factors were different for the three mutation types and highest at low uv-doses (3.4, 5.0 and 22 for c, b and e respectively). The uv-dose curves of mutation induction in normal $\varkappa$ are of the 2 hit type, but for BU-$\varkappa$ they were significantly less curved indicating the participation of 1-hit-processes in premutation production. It is concluded that inhibition of dark repair (HCR) of lethal lesions and premutations in BU-DNA is not the only reason for the differences in uv-sensitivities but that production of other species of uv-products in BU-DNA than in normal DNA also plays a role. (auth)

40638 INDUCTION OF RESPIRATORY DEFICIENCY IN YEAST BY ULTRAVIOLET IRRADIATION. Uchida, Akira (Kobe Univ., Japan). Mem. Fac. Sci., Kyoto Univ., Ser. Biol., 1: 8-21(Nov. 1967).

The nature of the nonchromosomal gene that controls respiratory competence in yeast (Saccharomyces cerevisiae) was investigated. By irradiating diploid cells with uv light, its effect of inducing respiratory deficiency was compared with its killing effect. The results obtained were as follows. The rates of killing and respiratory deficiency mutation owing to uv irradiation varied according to growth phase, but the ratio of the two rates did not. The rate of recovery from respiratory deficiency-inducing effect was less than that of recovery from killing effect both in light and darkness, especially in the latter. Preculturing of cells in a 5-fluorouracil-containing medium raised the cell killing effect of uv light conspicuously, but not so much for respiratory deficiency mutation. The nature of the nonchromosomal gene is discussed. (auth)

40639 BEHAVIOUR OF BALANCED LETHAL GENES OCCURRING IN PROGENY OF X-RAYED RICE. Katayama, Yo-

shiwo; Shida, Shojiro (Miyazaki Univ., Japan). Idengaku Zasshi, 43: 129-36(May 1968).

The progeny of a chlorophyll variant in x-irradiated rice were self-fed, test crossed with normal green rice, and treated with γ radiation. Crossing experiments resulted in mutant plants that were green, greenish yellow, and light yellow. It was assumed that the mutant yellow plants resulted from two recessive lethal genes that were unable to undergo normal chlorophyll formation. Gamma-ray treatments of the mutant strain induced a new mutant strain that showed a segregation of greens, yellows, and faint yellows in a ratio of 3:3:2. A new recessive mutation was thought to be the explanation of these results. (H.L.W.)

40640 EFFECTS OF GAMMA RADIATION ON PRIMARY NON-DISJUNCTION OF THE X CHROMOSOME OF DROSOPHILA MELANOGASTER. Glotoff, N. W.; Timofeeff-Ressovsky, N. W. (Inst. for Medical Radiology, Obninsk, USSR). Stud. Biophys., 2: No. 1, 27-31(1967). (In German).

Two-day old females were γ-irradiated and mated with normal and bar-eyed males. The percentage of non-disjunction in the offspring was slightly higher than that occurring spontaneously in other strains of flies. Since the radiation effect is independent of genetic strain differences, it was assumed that the mechanisms of the radioinduced non-disjunction and non-disjunction produced by genetically different strains were different. (H.L.W.)

40641 THE INDUCTION OF BIOCHEMICAL AND MORPHOLOGICAL MUTANTS IN THE MOSS PHYSCOMITRELLA PATENS. Engel, Paulinus P. (St. Benedict's Coll., Atchison, Kan.). Amer. J. Bot., 55: 438-46(Apr. 1968).

Mutants were induced by treatment of either spores or protonemal cells with ethyl methane sulfonate, N-methyl-N'-nitro-N-nitrosoguanidine, and x rays. The x-ray dose was varied in dose-survival experiments but the 37% survival dose (80 KR) was routinely used for mutagenic treatment of spores (1×10^5 spores/ml) and protonemal cells at 89 R/sec at 250 KV. Thiamine, p-aminobenzoic acid, niacin, and yeast extract auxotrophs were obtained. Growth response to various supplements was studied in the auxotrophic mutants. An x-ray-induced, niacin-requiring mutant (nic-1) grew well on either 2.0 μg/ml niacin or 0.5 μg/ml nicotinamide. Five yellow mutants and 2 morphological mutants were induced. The chlorophyll content of the yellow mutants was reduced 35 to 65% of wild type. The self-sterile, p-aminobenzoic acid-dependent mutant was used as the archegonial parent in crosses with a yellow mutant and a morphological mutant. The self-sterility of the p-aminobenzoic acid-requiring mutant appeared to be pleiotropically related to the auxotrophic condition, since self-sterility does not segregate from nutritional dependence in progeny of crosses. On the basis of tests with heterozygous diploids obtained by aposporous regeneration of capsule cells, two mutant alleles were shown to be recessive to their respective wild-type alleles. (BBB)

40642 THE FREQUENCY OF RECESSIVE LETHALS IN AN IRRADIATED MOUSE POPULATION. Sheridan, William; Wardell, Ingrid (Lab. of Radiation Genetics, Stockholm). Mutat. Res., 5: 313-21(May-June 1968).

Male offspring of the 14th generation of a mouse population in which the males of each generation were given 276 R x rays to the spermatogonia were mated in back-crosses to their daughters in order to determine the rate of recessive lethals. They were also outcrossed to females of the CBA strain for studies of dominant effects. Male offspring of the corresponding control population were tested in a similar way. The rate of induced recessive lethals among the offspring to the irradiated population was calculated to be 8.46%. Comparisons of results in the dominance tests for males assumed to be lethal-free and those suspected of being heterozygous for recessive lethals gave no indications of overall dominant deleterious effects that might have led to selection against lethal bearers. It was concluded that the low frequency of induced recessive lethals was probably attributable to a low rate of induction. (auth)

40643 GENETIC EFFECTS OF CUMULATIVE X IRRADIATION ON THE SECONDARY SEX RATIO OF THE LABORATORY RAT. Havenstein, G. B.; Taylor, B. A.; Hansen, Janet C.; Morton, N. E.; Chapman, A. B. (Univ. of Wisconsin, Madison). Contract AT(11-1)-697. Genetics, 59: 255-74(June 1968). (COO-697-11).

An experiment utilizing an inbred line of rats was conducted to estimate the number of induced sex-lined recessive lethals following either maternal or paternal irradiation of ancestors. The experimental procedures and methods of analysis are described. The data provide upper 95 percent confidence limits of 0.62×10^{-4} and 2.79×10^{-4} induced recessive sex-linked lethals per irradiated X-chromosome per R of exposure for oocyte and spermatogonial irradiation, respectively. The relationship of these estimates to those from the mouse is discussed. (auth)

40644 THE EFFECT OF PRE-FERTILIZATION MATERNAL IRRADIATION ON PRENATAL, PERINATAL, AND POSTNATAL SURVIVAL IN THE ALBINO RAT. Havenstein, G. B.; Chapman, A. B. (Univ. of Wisconsin, Madison). Contract AT(11-1)-697. Genetics, 59: 275-83(June 1968). (COO-697-12).

Estimates of the numbers of induced autosomal recessive lethals affecting the size of the litter at birth and postnatal survival were made following nine generations of cumulative maternal pre-fertilization x irradiation. The data provide an upper 95 percent confidence limit of 4.1×10^{-4} induced lethals per genome per roentgen of exposure for pre- and perinatal lethals affecting the live litter size at one day of age. Data on litter size at 21 days of age and at 69 days of age provided upper 95 percent confidence limits of 5.0×10^{-4} and 5.7×10^{-4} induced lethals per genome per R, respectively. The relationship of these estimates to those from the mouse is discussed. (auth)

40645 WHOLE-BODY IRRADIATION AND HUMAN CHROMOSOMES: CYTOGENETIC STUDIES OF THE PERIPHERAL BLOOD AND BONE MARROW LEUKOCYTES SEVEN YEARS AFTER TOTAL-BODY IRRADIATION. Goh, Kong-oo (Oak Ridge Inst. of Nuclear Studies, Tenn.). Radiat. Res., 35: 155-70(1968).

Results of cytogenetic studies of cultured peripheral blood leukocytes and direct bone marrow preparations from six patients, 7 years after accidental total-body exposure to mixed fast neutrons and gamma rays, indicated that: the modal chromosome number was 46; 79 (15.4%) of the 512 peripheral leukocyte and 25 (11%) of the 227 direct bone marrow metaphases were abnormal cells; 46 (9%) metaphases of the peripheral blood and 7 (3.1%) in the bone marrow had chromosomal abnormalities suggesting an X_1 cell; a smaller G chromosome, morphologically similar to the Philadelphia chromosome (Ph^1), was found in 13 (2.5%) and 12 (5.3%) of the peripheral blood and bone marrow metaphases, respectively; dicentrics and ring chromosomes were found in the peripheral blood, but not in the direct bone marrow. The findings suggest that radiation causes chromosomal aberrations in the cultured peripheral blood leukocytes as well as in the bone marrow cells, presumably the myeloid cells. No definite conclusion could be reached about the significance of the smaller G chromosome. An alternate explanation to the long-lived cell theory proposed by others to account for the X_1 cells would be that a substance is produced or activated by total-body irradiation and remains capable of affecting the chromosomes for extensive lengths of time. (auth)

40646 INCIDENCE OF XO MICE AFTER X-IRRADIATION OF SPERMATOGONIA. Leonard, A. (CEN, Mol, Belgium); Schroeder, J. H. Mol. Gen. Genet., 101: 116-19(1968).

Tabby male mice ($X^{Ta}Y$) were irradiated with 600 R of x rays and mated in the post-sterile period to untreated C3H females (X^+X^+). The incidence of XO females after x irradiation of the spermatogonia was not significantly different from the rate found in the control series. The phenotype of these exceptional females indicates that they are patroclinous XO females. Chromosome counts performed on bone-marrow show that most of the cells have 39 chromosomes as compared to 40 found in the controls. (auth)

40647 RADIATION EXPERIMENTS WITH STREPTOCARPUS WENDLANDII. Oehlkers, Friedrich (Univ., Freiburg i. B.). Mol. Gen. Genet., 101: 140-54(1968). (In German).

Pollen grains of Streptocarpus wendlandii were irradiated with 5 kr and applied to the stigma of untreated plants. In the first generation deficiencies of growth character were frequent. Besides that a great number of the plants was lacking of 1 to 3 chromosomes. The resulting chromosomal variations were compared with corresponding variations found in previous experiments with Str. rexii. It was found, e.g., that as a result of the x irradiation the number of chromosomes will be reduced in Str. rexii more than in Str. wendlandii. In other respects both species behave much the same, as contrasted with Str. rexii, which is known to possess a cytoplasm different from that of Str. wendlandii (Oehlkers, 1938). Str. wendlandii produced only few pollen steriles in X_1. On the other hand, in X_2 numerous mutations arose in Str. wendlandii, but not in Str. rexii. At least four of them seem to have been present within the genotype of Str. wendlandii before treatment, as they arose repeatedly in different X_2-progenies. These mutations must have been suppressed by an unknown plasmatic or chromosomal factor, and the suppression was released after radiation. Three of these mutations control morphological features, another one may be designated as feminization-factor, because anthers, corolla, and calyx of the flower are reduced to green rudimentary leaves carrying ovula at their margins. In these flowers petals can be open and flat or incurved. A fertilization is only possible with the central pistil. During seed development the ovary will increase in size but it does not twist. Thus it was evident that this factor was compatible with both the rexii- and the wendlandii-cytoplasm. Two more mutations arose after crossing with Str. rexii: calycanthemy

and kleistogamy. The latter was found within all X_6-progenies without an exception. The feminization-character, that was induced by x rays, is not identical with the former known character called "super-female," that appears after crossing Str. wendlandii × rexii, and that is caused by interaction between the cytoplasm of Str. wendlandii and the chromosomes of Str. rexii. (auth)

40648 INFLUENCE OF CAFFEINE ON REPAIR OF UV-PREMUTATIONS OF ESCHERICHIA COLI. Horneck-Witt, G.; Kaplan, R. W. Mol. Gen. Genet., 101: 123-30(1968). (In German).

The frequency of uv-induced S3-mutations (resistance to 3γ Streptomycin/ml) in E. coli B/phr⁻/MC_2 was not significantly increased by postincubation in NB with caffeine, though an increase is to be expected if caffeine would inhibit the dark repair of the S3-premutations. The frequency was even decreased by high (≥0.1%) caffeine concentrations which indicates an enhancement of the (caffeine-resistant)repair. This enhancement may be caused indirectly by the observed prolongation by caffeine of the lag phase which gives more time for repair. Also the strong photoprotection and (indirect) photoreversion of the S3-mutations in this (non-photoreactivable)strain were not influenced by caffeine-posttreatment. Thus, the dark repair assumed to be stimulated by pre- or post-illumination would be of the caffeine-resistant type. The repair of S3-premutations occurring during post-treatment in saline was inhibited by caffeine. Also the dark-reactivation of cells killed by uv was inhibited by caffeine in the NB-agarmedium. It is assumed that the repair of S3-premutations going on in NB-suspended cells is due to a mechanism which is not or only weakly inhibitable by caffeine and which is different from the caffeine-sensitive mechanism working under hunger conditions (perhaps by excising uv-products). Since reactivation of killed cells is caffeine-sensitive but reversion of S3-premutations is caffeine-resistant in NB-cells the uv-induced lethal lesions must be different from the S3-premutations. (auth)

40649 THE RESPONSE OF HUMAN CHROMOSOMES TO IONIZING RADIATIONS: IN VITRO STUDIES. Evans, H. J. (Univ. of Aberdeen, Scotland). Proc. Roy. Soc. Edinburgh, Sect. B: 70: 132-51(1968).

The experiments discussed involve the irradiation of cells in early interphase and observation of chromosomes at the first mitosis following radiation exposure. Irradiation of such G_1 cells results in the formation of chromosome-type aberrations that are a consequence of breaks or exchanges involving the whole chromosome, both chromatids being affected in the same way and at identical loci. Results indicate that human peripheral blood leucocyte chromosomes may be far more sensitive to radiation damage than has hitherto been supposed. Yields of dicentric aberrations obtained with x-irradiated pollen cells of Tradescantia and root-tip cells of Vicia were compared with the human data. The human cells were much more sensitive in the production of interchange aberrations and at an aberration yield of about 0.4 dicentrics per cell, the human chromosomes are respectively three to five times more sensitive than Tradescantia and Vicia chromosomes. A similar order of sensitivity exists for total aberrations, although because of the metacentric nature of the Tradescantia chromosome complement the centric ring aberrations in this species comprise a larger proportion of the total aberrations than in the Vicia and human complements. Although the plant species have very much larger nuclei with five to ten times as much DNA as the human nuclei, man has far more chromosomes and his high chromosome number may be an important factor in influencing the yield of interchange events. X-ray kinetic data indicate that most exchange aberrations are the consequence of the effects of 1, and not the interaction of 2, electron tracks. If this is true, it must mean that in man a chronic x-ray dose may be almost as effective in inducing genetic damage as an acute exposure. (BBB)

40650 RECOMBINATION-DEFICIENT MUTANT OF SALMONELLA TYPHIMURIUM.Wing, Jennifer P.; Levine, Myron; Smith, Hamilton O. (Univ. of Michigan, Ann Arbor). J. Bacteriol., 95: 1828-34(May 1968).

A recombination-deficient (Rec⁻) uv-radiosensitive mutant of Salmonella typhimurium was isolated. The mutant grew more slowly than the wild-type strain and degraded its DNA extensively both during normal growth and after uv irradiation. Evidence was presented that a growing Rec⁻ population consists of two types of cells, one that can divide and one that cannot. (auth)

40651 STUDIES OF CHROMOSOME DAMAGE AND MITOTIC RESPONSE IN VIVO IN X-IRRADIATED MAMMALIAN EPITHELIUM. Sobkowski, Francis John. Rochester, N. Y., Univ. of Rochester, 1966. 205p.

Thesis.

Results are reported from a quantitative study of the x ray induction and persistence of visible chromosome lesions in vivo, correlated with mitotic activity, in the epithelial cells of the hamster cheek pouch, at intervals of two, six and 24 hr, one wk, and three months after single radiation exposures of 50, 100, 400, or 800 R. The numbers and types of chromosomal lesions, as well as the number of chromosomes, were recorded for each scorable metaphase. Mitotic activity (mitotic index) of the epithelium and the histopathologic changes in the epithelium and sub-epithelial tissues were recorded for correlation with the data on chromosomal changes. Degeneration and necrosis of epithelial cells were noted histologically at six and 24 hrs and one wk, the degree of these changes being directly related to the exposure level. The degree of sub-epithelial inflammation was directly related to exposure level, and the rate of disappearance of this inflammation varied inversely with exposure level. The maximum inflammatory response for all exposure levels was recorded 24 hours after irradiation. (Disser. Abstr.) (TSS)

40652 GENETIC EFFECTS OF CUMULATIVE IRRADIATION IN THE FEMALE RAT. Havenstein, Gerald Bryce. Madison, Wis., Univ. of Wisconsin, 1966. 203p.

Thesis.

The effects of cumulative x irradiation on the descendants of rats from irradiated female ancestors were studied. The methods of analysis were patterned after the genetic load theory of Morton et al. (1956) and Crow (1958). This theory was modified to estimate the average mutational effects of a 450 R dose of maternal irradiation received each generation for a period of nine generations. Three additional generations of data were collected without irradiation. Traits studied included fertility, sex ratio, and numbers of live and dead young at one day of age, survival from one to 69 days of age, the average age at opening of the vagina, 21-day body weight, and 21- to 42-day and 42- to 69-day weight gains. (Disser. Abstr.) (TSS)

40653 THE EFFECT OF HERBICIDES ON RHIZOBIUM. III. INFLUENCE OF HERBICIDES ON MUTATION. Kaszubiak, Henryk (Dept. of Plant Genetics, Poznan, Poland). Acta Microbiol. Pol., 17: 51-8(1968).

The influence of dinitrophenol herbicide (Aretit), urea herbicide (Afalon), carbamate-urea herbicide (Liro-betarex), and triazine herbicide (Simazin) on the appearance of Rhizobium mutants resistant to streptomycin, erythromycin, and bacteriophage was studied. When the mutagenic property of a herbicide was detected, the correlation between resistance to a herbicide and uv radiation was tested. Previous data suggest that the increase of acquired resistance to each mutagen may be accompanied by the increase of resistance to uv radiation. Lethal doses of Afalon and Aretit exerted a mutagenic action on Rhizobium meliloti. Both herbicides were selectively toxic for certain mutants of Rhizobium and limited the frequency of their appearance. Mutagenic action of Afalon and Aretit depended upon the pH of the medium. There was no correlation between resistance to Afalon and Aretit, and the resistance of uv radiation. No mutagenic effects of Liro-betarex and Simazin on Rhizobium were found. (BBB)

40654 SOME RESULTS OF STEPWISE SELECTION OF ACTINOMYCES AUREOFACIENS, STRAIN LS-B536, PRODUCING CHLORTETRACYCLINE AND VITAMIN B_{12}, WITH THE USE OF ETHYLENEIMINE, ULTRAVIOLET RAYS, AND COMBINATIONS OF THEM. Alichanian, S. I.; Romanova, N. B. (All-Union Antibiotics Scientific Research Inst., Moscow). Antibiotiki, 10: 1113-17(Dec. 1965). (In Russian).

Natural and induced variations of A. aureofaciens, strain LS-B536, were studied with respect to antibiotic and vitamin production. It was found that in the presence of a greater degree of natural variability, the mutagenic effects of ethylenimine, uv radiation, and a combination of the two agents appeared to be more effective with respect to vitamin B_{12} production than to chlortetracycline production. In the production of the antibiotic, the reduction of the degree of variability occurred at the expense of an increase in a number of variants approaching the activity level of controls, i.e., 100%. The frequency of less active variants with respect to the vitamin B_{12} and chlortetracycline synthesis was higher than the frequency of highly active variants. Treatment with ethylenimine and uv radiation influenced the selection rate in a different way with respect to synthesis of the two compounds. The combined treatment proved to be considerably more effective in selections relevant to the production of vitamin B_{12} than to the production of the antibiotic. (BBB)

40655 EVOLYUTSIYA POLULYATSIY I RADIATSIYA. (Radiation and the Evolution of Populations). Dubinin, Nikolai Petrovich. Moscow, Atomizdat, 1966. 742p.

An investigation of the new direction in evolutionary theory known as population genetics as proposed by the author is the foundation for this new field of study. The theoretical and experimental bases of general and radiation genetics of popula-

tions, essential to understanding the way in which radiation produces new evolutionary forms of organisms, and to developing methods for selecting plants, microorganisms, and animals for these new evolutionary forms of organisms, are considered. Mathematical theory of population genetics and population genetics of populations of microorganisms are not treated. A detailed bibliography is included. The book is intended for biophysicists, radiobiologists, botanists, zoologists, geneticists, and evolutionists, as well as for students at medical and agricultural institutes and all those interested in modern genetics. (ATD)

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Refer also to abstracts 40300, 40583, 40777, 40823, 40854, 40869, 40941, 41382, 41440, and 42150.

40656 (AEET-273) GAMMA ACTIVITY OF THE FOOD SAMPLES IN INDIA DURING THE PERIOD 1963–65. Deshpande, A. S.; Vohra, K. G. (Atomic Energy Establishment, Trombay (India)). 1966. 19p. (A-AC-82/G/L-1164). Dep.

Data are presented on the content of ^{144}Ce, ^{125}Sb, ^{106}Ru, ^{137}Cs, $^{95}Zr-^{95}Nb$, and ^{54}Mn in cereals, vegetables, miscellaneous foodstuffs, composite meals, and grasses collected at Bombay during 1963 to 1965. Data on a few samples of imported cereals (USA) consumed in India are also included. (B.S.L.)

40657 (AD-651224) BULGUR WAFER AND ADJUNCTS FOR FALLOUT SHELTER RATIONS. Annual Report, July 1, 1965–June 30, 1966. Shepherd, Allan D.; Horvat, Robert J.; Ng, Hawkins; Lane, William G. (Agricultural Research Service, Albany, Calif. Western Regional Research Lab.). June 30, 1966. Contract OCD-OS-62-54. 36p. CFSTI.

The development of new stability-evaluation methods for Bulgur wafers and adjuncts is discussed. These methods include chemical-physical determinations and taste-panel evaluations of their storage stability. Chemical-physical determinations include; acid fraction, low-level oxidation, acceleration of rancidity, and oxygen uptake. (E.R.B.)

40658 (CEA-R-3424) RELATIONS FONDAMENTALES ENTRE TRANSFERT LINEIQUE D'ENERGIE DOSE ABSORBEE, KERMA ET EXPOSITION APPLICATION AUX CHANGEMENTS DE MILIEUX. (Fundamental Relationships Between Linear Energy Transfer, Absorbed Dose, Kerma, and Exposure. Application to Changes of Mediums). Joffre, Henri; Pages, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb. 1968. 39p. (In French). Dep.

After briefly defining the quantities used in dosimetry and presenting them with a view to their simple adaptation to health physics problems, simple mathematical relations were established to express the absorbed dose, kerma, and exposure in the case of electrons and photons, and also relations between these various quantities considered in air. The variations in these quantities at the interface between the air and the soft tissues of the organism and in depth in the tissues were studied. The numerical values of the discontinuities liable to appear at the interface and the values obtained, relative to air, after electronic equilibrium is established in depth in the tissues are given. An example of application to dosimetry is also given in the case of an aluminium-walled ionization chamber. Also the conditions to be fulfilled in order to make a direct measurement of the absorbed dose in the tissues are presented and discussed. (auth)

40659 (COO-1733-1) A STUDY OF UNSUPPORTED ^{210}Po FOR ION EXCHANGE IN SOIL AND UPTAKE IN VEGETATION. First Technical Progress Report, August 15, 1967–May 1, 1968. Watters, Robert L.; Johnson, J. E. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). May 8, 1968. Contract AT(11-1)-1733. 27p. Dep. CFSTI.

Equilibrium distribution coefficients for ^{210}Po between Colorado soil horizons and aqueous solutions and the polonium uptake of edible vegetables from a Brown soil of known ^{210}Po content were determined. Experimental procedures and analytical techniques that were used are described. A list of proposed publications and papers and descriptions of the Nunn Silty Clay Loam and Darling soils are presented. (B.S.L.)

40660 (EUR-3640) RADIOACTIVE CONTAMINATION OF FOODSTUFFS IN THE COUNTRIES OF THE COMMUNITY IN 1965. (European Atomic Energy Community). 1967. 79p. (In several languages). Dep.

Data are presented on the content of ^{137}Cs and ^{90}Sr in milk, cheese, cereals, fruits, vegetables, potatoes, meats, and eggs of Belgium, Germany, France, Italy, and the Netherlands during 1965. Table and graph that illustrate the pattern followed in the course of the year are included. The average milk contamination for these countries was compared with that of the United States, Canada, and the United Kingdom. The estimated average intake of ^{90}Sr was 9,010 pCi; this corresponded to 34.3 pCi/gCa in the diet. (B.S.L.)

40661 (HASL-197) FALLOUT PROGRAM. Quarterly Summary Report, March 1–June 1, 1968. Hardy, Edward P. Jr.; Rivera, Joseph (New York Operations Office (AEC), N. Y. Health and Safety Lab.). July 1, 1968. 578p. Dep. CFSTI.

This report presents current data from the HASL Fallout Program, the UKAERE Health Physics and Medical Division, EURATOM Joint Nuclear Research Center, the National Radiation Laboratory in New Zealand, and the Division of Biological and Medical Research at Argonne National Laboratory. The initial section includes four summaries of strontium-90 and cesium-137 measurements of ocean water submitted by the Naval Radiological Defense Laboratory, Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, and Lamont Geological Observatory. In addition, the initial section consists of interpretive reports and notes on strontium-90 fallout in the Atlantic Ocean, methods of analysis of soil radioactivity, stratospheric inventories 1967–68, exchange of fallout collectors between the UKAERE and HASL, and strontium-90 in human vertebrae (1967). Radionuclide levels in stratospheric air, surface air, fallout, milk, other diet components, and tap water, are given in tabular form. A bibliography of recent publications related to radionuclide studies is also presented. (auth)

40662 (JPRS-43578) PROTECTION OF RESPIRATORY ORGANS AGAINST RADIOACTIVE SUBSTANCES. Gorodinskii, S. M.; Skvortsova, T. N.; Shcherbakov, V. L. Translated from Gig. Tr. Prof. Zabol., 11: No. 9, 13-16(1967). 8p. CFSTI.

Respirators for protection against radioactive aerosols are discussed with emphasis on the efficiency of filtering materials used. Improvements in disposable respirators are described. Characteristics of three types of respirators are tabulated with regard to filter materials, resistance to respiration at 30 liters/min, effectiveness against particles with average radius of 0.15 μm, and conditions of use. Pneumatic suits for insulation of respiratory organs and body surface are described. An insulating overall suit is recommended for cases where hose-type protective suits can not be used; it is based on a cycling system for circulating the gas mixture. (H.L.W.)

40663 (LA-DC-9418) ATTENUATION OF FAST NEUTRON BIOLOGICAL DOSE IN NONHYDROGENOUS SHIELDS FOLLOWED BY THIN HYDROGENOUS SHIELDS. Dudziak, Donald J. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 4p. (CONF-680601-5). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Fast-neutron biological dose rates were determined for a Po-Be source in the center of a spherical array of lead and polyethylene using spatial-spectral flux distributions from S_8 and P_3 calculations and dose conversion factors based on Snyder and Neufeld's data. A formula is presented for calculation of dose rates for any distance from the center of the sphere. Values of $4\pi r^2 D$ were found to decrease exponentially from 5 to 60 cm of lead, for polyethylene thickness, t, between 3 and 41 cm. The exponential coefficient magnitudes are then the effective removal cross sections. Studies with a Ra-Be source spectrum show these cross sections to slightly underestimate the attenuation, but by less than 10%. (H.L.W.)

40664 (NP-17466) ABSORBED DOSES FROM ^{133}Xe. Technical Memorandum No. 84. Matthews, C. M. E.; Fowler, J. F.; Turner, P. C. R. ([Medical Research Council, London (England). Radiotherapeutic Research Unit]). May 23, 1962, Revised Oct. 7, 1963. 10p. Dep.

The doses absorbed by lungs, fat, gonads, and other tissues following the breathing of ^{133}Xe at a concentration of 350 μCi/l for 2 min was calculated using the physiological data of H. B. Jones (1950). Results are tabulated. The lower values are for a 70 kg body containing 5% fat by weight, and the upper values for 50% fat. The doses will be increased in some patients because of slow washout from a part of the lungs. For example, for one patient with emphysema the doses would be multiplied by 3.5 for $^3/_4$ of the lung and by 6 for $^1/_4$ of the lung. It is concluded that the absorbed doses from this use of ^{133}Xe are relatively safe. (auth)

40665 (NP-17467) CALCULATION OF THE MAXIMUM PERMISSIBLE CONCENTRATION OF ^{133}Xe IN A LIMITED VOLUME OF AIR. Technical Memorandum No. 90. Silvester, J. Ann ([Medical Research Council, London (England). Radiotherapeutic Research Unit]). Apr. 22, 1964. 9p. Dep.

Xenon-133 is used for clinical and experimental investigations of lung function. Xenon-133 is an inert gas and almost the entire radiation dose to a person surrounded by and inhaling the gas for more than a few minutes is from external radiation from the surrounding gas; only a small amount is from gas held in the lungs or other body organs and tissues. The doses to the skin, eyes, lungs, and whole body are determined for exposure in a constant concentration of G μCi/l of ^{133}Xe. (auth)

40666 (NYO-3364-44) RADIOCESIUM CONTAMINATION OF BEER IN NORWAY. (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). [1967]. 6p. Dep. CFSTI.

The ^{137}Cs content of Pilsner beer from four Norwegian breweries was determined for the years 1962 through 1967. No marked seasonal variations or increase in content was observed from 1962 to 1965; from 1965 on, a marked decrease occurred. The ^{137}Cs content of the components of beer (water, hops, malt and yeast) was determined to find out why the content in the beer from the four breweries was so different; little or no difference was noted in component content. The difference was attributed to differences in the brewing methods that favored the precipitation of ^{137}Cs before the beer was bottled. It was noted also that the content of ^{137}Cs in Norwegian Pilsner beer almost exclusively originated from imported materials. (B.S.L.)

40667 (SC-DC-68-2108) LASER EYE AND SKIN HAZARD EVALUATIONS. Burnett, W. D. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1968. Contract AT(29-1)-789. 29p. (CONF-680503-1). Dep. CFSTI.

A method is presented for the systematic evaluation of laser direct-beam hazards to the eyes and skin. The three parameters required for calculation of the exposure intensity incident on the surface of the eye or skin were laser output, laser beam divergence, and the range. Knowledge of the exposure intensity was not considered to be sufficient for evaluation of laser hazards to the eye since optical transmission characteristics of the eye account for retinal exposure. The hazards from exposure of the eye to uv and infrared wavelengths are also discussed. (B.S.L.)

40668 (STI/PUB-124) RISK EVALUATION FOR PROTECTION OF THE PUBLIC IN RADIATION ACCIDENTS. Safety Series No. 21. (International Atomic Energy Agency, Vienna (Austria)). 1967. 78p. IAEA $2,00; Austrian Schillings 52,-; 14/2 stg; F Fr 9,80; DM 8,-.

The report of a panel of experts who convened to define a range of reference doses of radiation that should be helpful in assessing the hazards of nuclear installations and in making policy decisions is presented. It was published on behalf of the World Health Organization and the IAEA. The report is separately available in French or English. (auth)

40669 (UCRL-70894) ESTIMATION OF THE INTERNAL DOSE TO MAN FROM THE RADIONUCLIDES PRODUCED IN A SURFACE EXPLOSION OF A NUCLEAR DEVICE. Ng, Yook C. (California Univ., Livermore. Lawrence Radiation Lab.). May 16, 1968. Contract W-7405-eng-48. 25p. (CONF-680507-4). Dep. CFSTI.

From Conference on Radiological Protection of the Public in Nuclear Mass Disasters, Interlaken, Switzerland.

A method was developed for estimating the internal dose to man from each radionuclide that is produced and released to the atmosphere following the detonation of a nuclear device. By means of this analysis the nuclides that could contribute most to the internal dose in man can be identified, the internal dose to tissues and organs of man can be estimated, and contributions of individual nuclides to this dose can be determined. Data are tabulated for: meter^2-rad via milk to the child's whole body and bone from ^{239}Pu fission products; meter^2-rad via milk to the child's whole body and bone from activation products produced in soil by a surface nuclear explosion; meter^2-rad via soil to the child's whole body and bone from ^{239}Pu fission products; fractional deposition as a function of post-detonation time; and total estimated dose to the child or infant from a hypothetical 1-Mt surface explosion of a thermonuclear device. The figures indicate that under conditions of normal agricultural practice substantial internal dosages could be experienced at very large distances from the site of detonation. (H.L.W.)

40670 EQUIVALENT FIELD PRINCIPLE AND ITS USE IN BEAM THERAPY DOSE CALCULATIONS. Patomaeki, L. K. (University Central Hospital, Helsinki). Brit. J. Radiol., 41: 381-3(May 1968).

A simple approximation for equivalent squares of rectangular fields was developed for use in different routine calculations with computers. This approximation is shown to be particularly satisfactory in the calculation of treatment times for a cobalt unit for fields of different shape and area. Parameters are presented which give the dose-rate for the Siemens "Gammatron I" as a function of the equivalent square, based upon the measured exposure rate. (auth)

40671 DETECTION, ESTIMATION, AND RADIOLOGICAL SIGNIFICANCE OF ^{110m}Ag IN OYSTERS IN THE IRISH SEA AND THE BLACKWATER ESTUARY. Preston, A.; Dutton, J. W. R.; Harvey, B. R. (Fisheries Radiobiological Lab., Lowestoft, Eng.). Nature (London), 218: 689-90(May 18, 1968).

Oysters were sampled in the vicinity of the U.K.A.E.A. factory at Windscale. In the gamma spectrometric analysis of samples collected in June 1967 a 0.89 MeV photon was observed, and this was confirmed as due to the presence of ^{110m}Ag. The analytical procedure adopted was described. The concentrations were apparently of trivial radiological significance. The source was probably the discharge from the Windscale factory. The ^{110m}Ag nuclide was also identified and measured in oysters from the vicinity of the Bradwell nuclear power station. The rate of discharge from this station was limited by the reconcentration of ^{65}Zn in the flesh of oysters, and comparison was made of ^{65}Zn and ^{110m}Ag in this situation. It was noted that ^{65}Zn was very restricted in dispersion compared with ^{110m}Ag. The latter was 3.3 times more radiotoxic than ^{65}Zn, but this difference was offset by the greater concentration factor for Zn in the flesh of oysters, and the two nuclides were of almost equal importance per curie released. In certain situations however ^{110m}Ag would be potentially the more hazardous nuclide to man. (UK)

40672 DIRECT DOSIMETRY OF X-RAY MICROBEAMS BY MEANS OF THERMOLUMINESCENCE OF NATURAL FLUORITE. Steinbach, Karl Heinz (Heiligenberg Inst., Ger.). Strahlentherapie, 134: 387-90(Nov. 1967). (In German).

A method is described for the direct dose measurement of x-ray microbeams (diameters between 500 and 1000 μ) by means of thermoluminescence of natural CaF_2. The dose rate was independent of the diameter of the radiation beam. The standard deviation of the values obtained was less than ±6%. (auth)

40673 FUNDAMENTAL MEDICAL PRINCIPLES UNDERLYING THE REGULATIONS ON IONISING RADIATION. Lafontaine, A. Belgicatom, Ass. Belg. Develop. Pac. Energ. At., Bull. Inform., No. 63, 3-6(1966). (In French).

The fundamental principles of the Belgian statutory provisions concerning health protection against ionizing radiation are based on the discernible relationships between irradiation and its biological consequences. In order to explain these relationships, the author considers the biological factors bound up with irradiation and the general features of radiation diseases, especially those of particular significance owing to the importance or the peculiar sensitivity to radiation insult of the damaged organs or tissues (skin, blood, bone, lens, gonads). The role of chemicals in the prevention and treatment of radiation injury is briefly considered. (Occup. Safety and Health Abstr.)

40674 STUDY OF OCCUPATIONAL EXPOSURE TO IONISING RADIATION IN CZECHOSLOVAKIA. Chysky, J.; Trousil, J. Prac. Lek., 18: 211-19(June 1966). (In Czech).

Personal film badge dosimetry was used in Czechoslovakia to survey the organization of radiation exposure monitoring of various workplaces and occupations in 1964. Data obtained during the monthly evaluation of exposure sustained by 3191 persons indicate that 82.04% of the latter received an annual dose inferior to one tenth of the allowable maximum, and that this maximum was exceeded in only 0.22% of cases. The authors stress the need to investigate all evidence pointing to high exposure levels on the spot, since in most cases intentional or accidental exposure of the dosimeter, but not of the worker, was found to have occurred (e.g., overall and dosimeter left at the workplace). (Occup. Safety and Health Abstr.)

40675 FILTER LENSES FOR RADIATION PROTECTION. J. Offic. Repub. Fr., No. 179, 6778(Aug. 4, 1965). (In French).

The standard is intrinsically concerned with filter lenses protecting the eye from industrial radiation hazards (ultraviolet, visible spectrum, infrared). It defines a scale of degrees of protection corresponding to given transmission factors for certain wave-lengths or parts of the light spectrum, and lays down specifications for optical tests designed to determine filter lens characteristics and for identification marks on filter lenses. The specifications are preceded by an introduction defining the physical and physiological concepts in the field of spectrophotometry, in the light of which the standard is to be understood. Procedures for testing the resistance of filter lenses to thermal shock and to heat, humidity and ultraviolet radiation are appended. (Occup. Safety and Health Abstr.)

40676 COMPUTER CALCULATION OF DOSE CONTRIBUTION TO REGIONAL LYMPHATICS FROM GYNECOLOGICAL RADIUM INSERTIONS. Durrance, Fred Y.; Fletcher, Gilbert H. (M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Radiology, 91: 140-8(July 1968).

By means of a rapid-computer program, isodose curves in all gynecological radium insertions can be obtained routinely and the dose delivered to the regional lymph nodes, as well as to the contiguous structures, can be determined. Parametrial irradiation can be adjusted to give a minimal total tumor dose to the regional lymph nodes. (auth)

40677 A STUDY OF THE PROTECTIVE EFFICIENCY OF FABRICS OF GARMETS, USED BY PERSONS WORKING UNDER CONDITIONS OF POSSIBLE ENVIRONMENT CONTAMINATION WITH RADIOACTIVE AND BACTERIAL AEROSOLS. Chetverikova, Z. S. Gig. Sanit., No. 4, 39-42(Apr. 1968). (In Russian).

The investigations revealed a definite relation between the protective efficiency of fabrics and their structure and the nature and type of their fibers. The protective efficiency of fabrics made of natural fibers was 1.5 to two times higher than that of fabrics of similar structure made of synthetic fibers. Fabrics made of lavsan and cotton fibers may be recommended for use in work with radioactive aerosols, as they provide sufficient protection, are easy to decontaminate, and are hard-wearing. (auth)

40678 A STUDY OF RELATIONSHIP BETWEEN THE EXTENT OF RADIOACTIVITY AND THE AMOUNT OF ATMOSPHERIC FALLS. Korenkov, I. P.; Novikov, Yu. V.; Kozlova, M. Z. Gig. Sanit., No 4, 30-4(Apr. 1968). (In Russian).

The existing relationship between the monthly average concentration of radioactive sediments and the level of atmospheric precipitation was studied. The finding was that no correlation existed between the quantity of radioactive sediments and the total amount of atmospheric precipitation. (auth)

40679 PROPERTIES OF GERMANIUM DETECTORS AND THEIR USES FOR GAMMA SPECTROMETRY. Adams, F. (Rijksuniversiteit, Ghent). J. Belge Radiol., 51: 40-8(1968). (In French).

The properties of germanium detectors, their manufacture and uses for gamma spectrometry are described. At the present time, there are germanium detectors available that are equal to the classical scintillation detectors for the measurement by gamma spectrometry. (auth)

40680 METHODS FOR MEASURING ABSORBED RADIATION DOSES. Claes, F. H.; De Roeck, J. (Research Inst., Gevaert-Agfa, Belg.). J. Belge Radiol., 51: 29-39(1968). (In French).

A photographic method for measuring the radiation doses absorbed, and for determining the nature and energy of ionizing particles is introduced. For measuring the absorbed dose by means of radiographic films, it is necessary to know the radiation energy spectrum. For this, one has to resort to nuclear emulsions. The advantages of nuclear emulsions compared to other so-called, classical detectors are given, together with their main parameters. Some examples of tracks recorded are shown. (auth)

40681 THE IODINE CONTENT OF HUMAN AND ANIMAL ORGANS, WITH PARTICULAR CONSIDERATION OF THE OVARIES. Weischer, Marie-Luise (Univ., Muenster, Ger.). Z. Gesam. Exp. Med., 146: 139-46(1968). (In German).

Iodine content of the thyroid glands, ovaries, adrenal glands, livers, spleens, and kidneys of 24 human corpses and mice, rats, and guinea pigs was determined by a sensitive photometric method. It was found that except for the thyroid gland the ovaries as a rule had the greatest iodine content, but in some cases, when the subjects died of infectious diseases, the adrenal glands contained more iodine than the other organs except the thyroid gland. Experiments showed that, at least in the rat, stimulation of the adrenal cortex was accompanied by an increase of the iodine content of this organ. There was no correlation between the iodine content of the thyroid gland and that of the other organs. (BBB)

40682 THE PROBLEM OF ^{137}Cs UPTAKE FROM THE FOOD. Abel, E.; Hluchan, E.; Mayer, J.; Durcek, K.; Kortus, J.; Uralova, M. (Vyskumny Ustav Hygieny, Bratislava). Cesk. Hyg., 12: 589-93(1967). (In Czech).

The ^{137}Cs content of milk from both lowland and mountain areas of Slovakia was determined as well as the average daily intake of ^{137}Cs from various meals, namely breakfast, dinner (soup and main meal), and supper, in a university catering establishment. The average values of ^{137}Cs in cows' milk in 1965 from the lowland production areas were 180 pCi/l and from the mountain areas 267 pCi/l. The values for sheep and goat milk, respectively, were 432 and 370 pCi/l in 1966 for mountain areas of production. The relation of ^{137}Cs content to potassium was also given. The average values of ^{137}Cs content of the daily diet for the university catering establishment in 1966 was 435 pCi; this value included the breakfast level of 54 pCi, dinner 254 pCi (154 pCi for soup and 96 pCi for main meal), and supper 135 pCi. The results were compared with those given for other nations. (BBB)

40683 SOME OBSERVATIONS ON 150 RECENT RADIATION SURVEYS IN DENTAL SURGERIES. McEwan, A. C. (National Radiation Lab., Christchurch, N. Z.). N. Z. Dent. J., 61: 248-55(Oct, 1965).

The present state of x-ray protection in dental radiography in New Zealand is assessed from the results of 150 successive radiation surveys carried out during March to May 1965. The dose per exposure, measured in air at the tip of the localizer cone for each machine, was found to vary from 50 to 5500 mR, the average value being 775. Most commonly the doses were in the range of 400 to 600 mR, the exposure times most commonly used being between 0.4 and 0.6 sec. However, timers were found or suspected to be inaccurate, and these often gave exposures that were of shorter duration than indicated by the timer. The true mean exposure time may have been somewhat smaller than the calculated mean of 0.54 sec. Where measurements showed that the field dia was greater than 8.6 cm, it was recommended that a lead diaphragm be fitted to restrict the field area. Of the 150 machines recently surveyed it was recommended that diaphragms be fitted to 25 (16.7%). (BBB)

40684 RELATIONSHIP OF BIOLOGICAL EFFECT TO DOSE-TIME-FRACTIONATION FACTORS IN RADIOTHERAPY. Ellis, Frank (Churchill Hospital, Oxford). pp 357-97 of Current Topics in Radiation Research. Vol. IV. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1968.

A review of the factors that affect the biological response to various dosage schedules is presented. Dose per fraction, interval between fractions, dose rates, oxygen effects, dose-time relations, clinical basis for quantitative estimates and calculation of the iso-effect dose, radiotherapeutic precision, application of the iso-effect dose calculation, nominal single dose (NSD), and rad equivalent therapy (RET) are discussed. In addition to total dose, total time, and RBE, the dose per fraction, number of fractions, interval between fractions and dose rate are all important in determining biological effect. An equation is presented that embodies these factors in an attempt to relate dose to biological effect. 63 references. (M.M.B.)

40685 STUDIES ON THE INHIBITION OF INTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM. Tanaka, Y.; Skoryna, S. C.; Waldron-Edward, D. Can. Med. Ass. J., 98: 1179-82(June 1968).

Lower-molecular-weight oligosaccharides with greater ability to prevent the absorption of radioactive strontium were produced by treating naturally occurring alginates with acid under different conditions. The partially degraded alginates are more active in preventing the absorption of radioactive strontium than the parent seaweed extract. Degraded alginates form relatively non-viscous solutions and are considerably easier to administer with food or in drinking water. When the proportion of guluronic acid in the degraded alginate is increased, the absorption of radioactive strontium is decreased. However, increased proportions of guluronic acid are more directly related to increased discrimination against strontium in favor of calcium in the presence of alginates. In evaluating alginate derivatives for practical application, the total yield of active material from the raw material must also be considered. (auth) (UK)

40686 THE M. D. ANDERSON METHOD FOR THE COMPUTATION OF ISODOSE CURVES AROUND INTERSTITIAL AND INTRACAVITARY RADIATION SOURCES. II. MATHEMATICAL AND COMPUTATIONAL ASPECTS. Batten, George W. (M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 673-6(Mar. 1968).

The design details of the implant radiation dosimeters in use at the University of Texas M. D. Anderson Hospital and Tumor Institute at Houston are described. Physical and clinical details are not discussed here, but they are treated in companion papers. The original computer program, RADCOMP I (RADiation COMPutation), which has been in clinical use for over 3 years, has recently evolved into RADCOMP II. These programs differ both in design detail and in over-all philosophy from an earlier computer program which was used at this institution before 1964. (C.H.)

40687 SOME ASPECTS OF RADIATION SAFETY FOR ELECTRON ACCELERATORS USED FOR BOTH X-RAY AND ELECTRON THERAPY. Karzmark, C. J. (Stanford Univ., Palo Alto, Calif.). Brit. J. Radiol., 40: 697-703(Sept. 1967).

Certain aspects of radiation safety for megavoltage electron accelerators used for both x ray and electron therapy, particularly linear accelerators are discussed. Such accelerators pose a specific radiation hazard. The hazard arises in ensuring that the devices and procedures required for the large reduction in electron beam current associated with the electron therapy modality are sufficiently rigorous, both technically and opera-

tionally, to render it exceedingly unlikely for patients to be exposed to excessive electron doses as a result of a technical failure and/or an operational inadvertence. This note describes some of the radiation safety features of a 5 MeV accelerator used routinely for both x ray and electron therapy. Included are a description of the x ray/electron therapy changeover procedure, the radiation monitoring system, the accelerator electron gun design, data on relevant failures, the use of secondary emission monitors, beam loading, and a number of peripheral considerations relating to radiation safety. (auth)

40688 RADIATION LEVELS IN THE BARREL CACTUS, FEROCACTUS WISLIZENI, AND THEIR RELATION TO SOME ASPECTS OF CACTI ECOLOGY. Koehn, Richard K.; Knowles, Barbara B. (Arizona State Univ., Tempe). Southwest. Natur., 12: 119-26(Aug. 4, 1967).

Radioassay of individuals of Ferocactus Wislizeni and other cactus species collected during 1964 and 1965 from a steep desert slope revealed the presence of radionuclide activity. Within the initial samples, a gradient of activity positively correlated with collection elevation was noted. Gradient formation is explained on the basis of individual rooting systems in conjunction with some extraneous source of radioactive material. A considerable decrease in radioactivity throughout the study period was noted. It appears likely that the activity detected in early samplings may have been a result of ejected radioactivity from an underground thermonuclear detonation and/or local deposition of natural-occurring radionuclides. The original source of radioactive material and its movement through the soil are speculated upon. (auth)

40689 STUDIES ON CHROMOSOME DAMAGE FOLLOWING IN VIVO HUMAN RADIATION EXPOSURE. Court Brown, W. M. (Western General Hospital, Edinburgh). Proc. Roy. Soc. Edinburgh, Sect. B, 70: 125-31(1968).

It is now possible to detect the effects of radiation at low doses on the basis of chromosome aberrations of lymphocytes in the peripheral blood; for example, an occupational dose of about 15 to 20 rad accumulated over a few years or the doses received during fluoroscopic procedures in diagnostic radiology may be detected by this means. It is anticipated that the development of automated techniques of chromosome counting and analysis will permit quantitative work to such low dose levels. The persistence of unstable aberrations is thought to be a reflection of the inherent potential of lymphocytes to survive for long periods of time between divisions. In other tissues, however, unstable cells would be quickly eliminated from tissues with a rapid cell turnover, for example the bone marrow. Evidence is now accumulating that each aberration does not necessarily represent a unique event. Irradiation may lead to the establishment of clones of cells, the members of a clone being characterized by having in common a structural chromosome aberration. Results from irradiated spondylitis and from subjects chronically and internally irradiated from exposure to Thorotrast suggest that, within the limitations of the present techniques, evidence for the presence of a clone can be obtained from the study of lymphocytes. When automated chromosome analysis becomes available, permitting analysis of greatly increased numbers of cells per sample, the study of cells from irradiated subjects may demonstrate a profile of stable aberrations. (BBB)

40690 RADIOLOGICAL HEALTH DATA AND REPORTS. Radiol. Health Data Rep., 8: 245-99(May 1967).

Reports and data are presented on the following activities: surveillance of fallout content of milk by state, national, Canadian, and Pan American milk surveillance programs during 1966 to 1967; estimates of daily intake of radioisotopes in California diet during May to Aug. 1966, and in Connecticut diet during July to Dec. 1966; gross radioactivity levels of surface waters in the United States during Nov. 1966; surveillance of radioactivity in airborne particulates and precipitations in the United States, Mexico, and Pan America during Jan. 1967; plutonium content of airborne particulates in the United States during Oct. to Dec. 1966; radioisotope content of Alaskan reindeer and Caribou during Oct. to Nov. 1966; and surveillance of environmental radioactivity levels at Mound Laboratory during Jan. to June 1966 and Rocky Flats Plant during July to Dec. 1966. Announcement is made by the Atomic Energy Commission of three underground nuclear tests at its Nevada Test Site during April 1967. Additional abstracts are included on two other sections of the journal. (E.R.B.)

For abstracts of individual sections see: 40691 and 40692.

40691 RADIOLOGICAL MONITORING OF THE NATIVE TEXAS COMMERCIAL OYSTER. Stanko, J. J.; Wukasch, M. C. (Texas State Dept. of Health, Austin, Tex.). Radiol. Health Data Rep., 8: 296-7(May 1967).

A program was undertaken as a joint project among groups in the Texas State Department of Health to collect, analyze and interpret radiological data on the native Texas commercial oyster (Crassostrea virginica). Analyses included α-, β-, and γ-radioactivity measurements of raw oyster meat obtained from Texas certified oyster houses that were known to harvest from reefs in question. The results of the project led to the establishment of a baseline level from which future contamination can be assessed, and maintenance of surveillance facilities in areas of potential sources of contamination can be established. (E.R.B.)

40692 ^{90}Sr, ^{137}Cs, AND ^{210}Po IN HUMAN TISSUES. Baratta, E. J.; Ferri, E. S. (National Center for Radiological Health, Winchester, Mass.). Radiol. Health Data Rep., 8: 298-9(May 1967).

The choice of organs for this study by the Public Health Service, was based on the function of the organ, the type of tissue it represented and whether it was reported that the radioisotopes under study tended to concentrate in that organ. The organs studied included lungs, liver, heart and kidney. Other organs were included when available. The content of ^{90}Sr, ^{137}Cs, and ^{210}Po was measured in samples of each organ and compared to predicted levels based on ICRP model studies. (E.R.B.)

40693 RADIOLOGICAL HEALTH DATA AND REPORTS. Radiol. Health Data Rep., 8: 415-89(Aug. 1967).

Reports and data are presented on the following activities: surveillance of fallout content of milk by State, National, Canadian and Pan American milk surveillance programs during 1967; food and diet surveillance activities in the United States and the United Kingdom; gross radioactivity levels of surface waters in the United States during Feb. 1967, ^{90}Sr content of surface waters in the United States during Oct. 1965 to June 1966, and radioactivity levels of surface waters in Washington during July 1965 to June 1966; radioactivity content of airborne particulates and precipitations in the United States, Canada, Mexico and Pan America during April 1967; routine samplings of ^{131}I content of bovine thyroid during Jan. to March 1967; and environmental radioactivity levels at Atomic International, Feed Materials Production Center and Oak Ridge Area during July to Dec. 1966. Also included is an announcement by the Atomic Energy Commission of one underground nuclear test at its Nevada Test Site during July 1967. Additional abstracts are included on three other sections of the journal. (E.R.B.)

For abstracts of individual sections see: 40694–40696.

40694 GROSS BETA RADIOACTIVITY IN FUCUS HYBRIDS (ROCKWEED) FROM THE NIANTIC ESTUARY, CONNECTICUT, 1961–1964. Hatfield, Thomas W. (Mitchell Coll., New London, Conn.); Skauen, Donald M.; Marshall, Nelson. Contract AT(30-1)-2678. Radiol. Health Data Rep., 8: 481-3(Aug. 1967).

Monthly measurements of gross β-radioactivity were made from the fall of 1961 through January 1964. The high levels observed were assumed to be from fallout. Ruthenium-103 and -106 contents, small but significant provided a clue to this assumption. Relative to the environmental and uptake routes, the following facts seem pertinent; fluctuations in β activity in Fucus follow closely changes in levels in air at Hartford-Providence station, highest observed results occurred during periods of greatest river discharge, and seasonal variations were evident in gross β-radioactivity. It was concluded that β-radioactivity in the air accumulates in the watershed and runs off with late winter thaws and melting. (E.R.B.)

40695 THE GALVESTON ENVIRONMENTAL SURVEILLANCE PROGRAM, 1966. Stewart, B.; Wukasch, M. C. (Texas State Dept. of Health, Austin, Tex.). Radiol. Health Data Rep., 8: 484-6 (Aug. 1967).

Sampling sites and schedules as well as the results of the air, seawater, milk, and silt radioactivity sampling program at Galveston, Texas in 1966 are given. The sampling program was initiated in 1962 when the Todd Shipyard was selected as the refueling and servicing site for the nuclear ship Savannah. With the exception of milk radioactivity levels, all categories sampled were at or below detection levels. Radioactivity levels in milk tended to follow national trends. (E.R.B.)

40696 RADIOACTIVE MATERIAL HANDLING PROBLEMS IN OIL AND GAS WELL LOGGING. Fontaine, J. H.; Flora, D. H. Radiol. Health Data Rep., 8: 487-9(Aug. 1967).

Radioisotopes are used in various ways to obtain information about reservoirs of oil and natural gas. Reservoirs can be located, movements of oil or gases followed and with the aid of sealed sources, the density and depth of materials can be determined. Problems arise in the storage and handling of such radioactive materials as sealed gamma sources, neutron sources and beta sources such as ^{131}I, ^{192}Ir, ^{46}Sc and ^{95}Zr. Adequate protective signs, procedures and clothing are in use at all sites in accordance with

standards specified by the Texas State Regulations for Control of Radiation. Routine instruction in the handling of radioactive materials is presented by state and national health services. (E.R.B.)

40697 RADIOLOGICAL HEALTH DATA AND REPORTS. Radiol. Health Data Rep., 8: 301-54(June 1967).

Reports and data are presented on the following activities: surveillance of fallout content of milk by State, National, Canadian, and Pan American milk surveillance programs during 1966 to 1967; surveillance of ^{90}Sr content of food in Chicago, New York City, and San Francisco during May and June 1967; gross radioactivity levels of surface waters in the United States during December 1966; ^{90}Sr content of tap water in New York City during March to November 1966; radioactivity content of waters in California during January to June 1966; radioactivity content of airborne particulates and precipitations in the United States, Canada, Mexico, and Pan American countries during February 1967; and environmental levels of radioactivity at AEC installations during 1966. Announcement is made by the AEC of four underground nuclear tests at its Nevada Test Site during May 1967. (E.R.B.)

40698 UMWELTRADIOAKTIVITAET UND STRAHLENBELASTUNG. Bericht III/67. (Environmental Radioactivity and Radiation Burden. Third Quarterly Report, 67). Bonn, Bundesminister fuer Wissenschaftliche Forschung, 1967. 180p. DM 11.--. (NP-17741).

The content of the radioactive materials in air, water, soil, and food materials, and the radiation burden of the population in the German Federal Republic measured during the third quarter of 1967 are reported in graphic and tabular form. (J.S.R.)

40699 LIFE TABLES. 39th CONTINUATION. RADIATION AND ATOMIC FISSION. PART 6. RADIOACTIVE CONTAMINATION OF FOODSTUFFS, AIR, AND WATER THROUGH NUCLEAR WEAPON TESTS. Herbst, W. (Univ., Freiburg i. B.). Vitalst. Zvilisationskr., 9: 111-15(June 1964). (In German).

Tables are given of the characteristics of radioactive contamination resulting from atomic weapon tests performed during 1945 to 1962; the average monthly amounts of fallout in Freiburg/Breisgau during 1957 to 1963; the amounts of ^{90}Sr, ^{54}Mn, ^{55}Fe, ^{124}Sb, and ^{204}Tl induced by neutron irradiation in the fallout measured in 1962/63; the worldwide distribution of ^{90}Sr measured as local fallout, worldwide deposition, in the atmosphere up to 30 Km altitude, in the stratosphere in the northern and southern hemispheres up to 20 Km altitude, and in the atmosphere between 20 and 30 Km altitude; the deposition of ^{90}Sr throughout the U.S.A. during 1961 to 1963; total accumulation of ^{90}Sr in New York during 1954 to 1963; ^{90}Sr content of vegetables, fruits, and hay during 1957 to 1962; ^{90}Sr content of various grains and flours during 1956 to 1963; ^{90}Sr content of meat, fish, eggs, and milk; ^{90}Sr content of milk from various regions of the U.S.A.; ^{90}Sr content of bone meal, dried fruits, and tea during 1961 to 1962; dietary ^{90}Sr content in the U.S.A. during 1959 to 1962; $^{90}Sr/Ca$ ratios in foodstuffs during 1960 to 1963 in New York; distribution of ^{90}Sr and ^{137}Cs content of German foodstuffs during 1962 to 1963; average ^{90}Sr content of bones of American children during 1958 to 1962; ^{131}I content of milk; ^{137}Cs content of foodstuffs in New York during November 1963; and ^{137}Cs content of man and milk in the U.S.A. during 1959 to 1963. (BBB)

40700 RADIUM CONTAMINATION INCIDENT IN IOWA. Oppold, James A.; Pelland, Earl E.; Campbell, C. L. (State Hygienic Lab., Iowa City, Iowa). J. Iowa Med. Soc., 56: 1226-8(Dec. 1966).

A minor Ra contamination incident in Iowa is described and evaluated. The contamination was not widespread and none of the personnel sustained any significant uptake. The decontamination was simplified by the complete cooperation of the physician. (TSS) (BBB)

40701 STATE HEALTH DEPARTMENT PROGRAM IN X-RAY PROTECTION. Myers, Ira L. (Alabama Dept. of Public Health, Montgomery). J. Med. Ass. State Ala., 36: 874-8(Jan. 1967).

Various methods to reduce unnecessary x-ray exposure of patients are discussed. The Alabama Department of Public Health initiated its protection efforts by recording measurements of base line radioactivity. A dental survey and correction program for deficiencies in filtration and collimation of x-ray machines has been completed. The medical x-ray unit registration, inspection, and regulation program including all professional sources is being extended to industrial sources. The Ra leak testing service was included in the control effort. Correction of mechanical and equipment defects is important for x-ray protection, and improvement in methods, techniques, and judgments by all personnel is required. (BBB)

40702 RADIATION PROTECTION FOR DIAGNOSTIC X-RAY FACILITIES. Meckstroth, George R. (Tulane Univ. School of Medicine, New Orleans). J. La. State Med. Soc., 119: 115-20 (Mar. 1967).

Various factors to be considered in radiation protection aspects of diagnostic x-ray facilities are incorporated into the Louisiana Radiation Regulations. The current recommendations for permissible radiation levels for several categories of workers and for the general population are discussed. The maximum permissible doses for three categories are given. The doses are specified for various organs and parts of the body. The permissible dose to nonradiation workers is less than that recommended for radiation workers and as the hazard is very much reduced, personnel monitoring is no longer necessary. Data for medical fluoroscopic, medical radiographic, mobile diagnostic, photofluorographic, and dental radiographic units are set forth in the Louisiana Radiation Regulations. (BBB)

40703 COMPARISON OF URANIUM CASES SHOWING LONG CHEST BURDEN RETENTIONS. West, C. M. (Union Carbide Corp., Oak Ridge, Tenn.); Scott, L. M. Health Phys., 12: 1545-55(Nov. 1966).

Five persons out of 2,500 monitored by in vivo spectrometry for uranium in the Y-12 plant had chest burdens with biological half-lives ranging from 380 to 1,470 days. Monitoring data from these persons showed ratios of chest burden to urine excretion rate of from 270 to 5,700. Comparison with cases previously reported revealed that these five cases generally showed retention functions with longer half-lives. Investigations have not to date delineated the reason for these unusual retention patterns. (Public Health Eng. Abstr.)

40704 ENERGY ALINEMENT OF GAMMA SPECTROMETERS. Coats, G. I. (Northeastern Rad. Health Lab., Winchester, Mass.); Goldin, A. S. Public Health Rep. (U. S.), 81: 999-1007(Nov. 1966).

Regular checking of instruments, followed by any corrective adjustments indicated, is requisite to proper operation of a gamma spectrometer. In addition, control charts for documenting and monitoring instrument performance need to be set up. In the event of elevated levels, the accuracy of such data will be indispensable to the application of sound procedures for corrective public health action. The recommendations in the paper are directed particularly to public health personnel who have not had extensive experience in the detailed use and calibration of gamma spectrometers. (Public Health Eng. Abstr.)

40705 RADIONUCLIDE LEVELS IN MILK, TOTAL DIET, AND HUMAN BONE COMPARED TO FEDERAL RADIATION COUNCIL ESTIMATES, 1965 AND 1966 ESTIMATES. Radiol. Health Data Rep., 8: 65-72(Feb. 1967).

The 1965 observed levels are in agreement with the predicted levels. The predicted levels for the next several years are too small to justify protective action limiting dietary intake. (Public Health Eng. Abstr.)

40706 MICROWAVE OVEN RADIATION HAZARDS IN FOOD-VENDING ESTABLISHMENTS. Suroviec, Henry J. (Pennsylvania Department of Health, Meadville). Arch. Environ. Health, 14: 469-72(Mar. 1967).

Of the units monitored, 71% released radiation in excess of 1 milliwatt/cm^2, and 16% released radiation levels of 10 milliwatts/cm^2 or above. The radiation intensities released appeared to depend on the construction design of the doors, with sliding doors providing the best seal to limit leakage. (Public Health Eng. Abstr.)

40707 CUMULATIVE GROUND DEPOSIT OF ^{137}Cs IN JAPAN. Yamagata, Noboru (Dept. Radiol. Health, Tokyo); Iwashima, Kiyoshi; Matsuda, Shunji; Tajima, Eisaku. Koshu Eisein Kenkyu Hokuku, 15: No. 3, 119-33(Sept. 1966).

Soil samples indicated that 94%, on the average, of total ^{137}Cs was concentrated in the upper 5 cm layer of soil and that the distribution pattern was similar to that of annual precipitation. (Public Health Eng. Abstr.)

40708 ULTRASONIC RADIODECONTAMINATION OF THE SKIN OF DOGS. Glicorijevic, J.; Zagorcic, A.; Bogovic, J.; Pavlovic, M. (Inst. of Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). Acta Vet. (Belgrade), 17: 309-14(1967). (In Slovak).

The skin of dogs was contaminated with solutions of ^{137}Cs and ^{144}Ce. Application of ultrasound in the therapeutic range (frequency 800 kc, intensity 0.5 to 2.4 w/cm^2) in water, a 5% solution of isotope carrier sequestering agent, or a 1% detergent solution resulted in decontamination superior to that achieved without the use of ultrasound. Radiographic and autohistoradiographic studies, in which the degree of transcutaneous resorption was determined, were used to establish residual decontamination and to check the effectiveness of the procedure. (JPRS)

40709 THORIUM X RADIATION MEASUREMENTS AFTER DETERMINATION OF THE CONTAMINATION FACTOR. Haike, Horst; Steltner, Dieter; Schulze, Hadwiga (Univ., Duesseldorf). Strahlentherapie, 134: 306-11(Oct. 1967). (In German).

Thorium X (^{224}Ra) radiation measurements were done in the Max Planck Institute for Biophysics, Frankfurt/Main, to determine the contamination factor of a sample of Ixthor Buchler, that was sold in 1952. The results of a newer Ixthor sample, now available, are, in regard to contamination, much better. The substance can be purchased in a chemically purer form and the danger of late damages by simultaneous administration of long lived radioactive substances with the intravenous injection of Th X has decreased. (auth)

40710 RECENT RADIOCARBON IN PLANTS. Iwakura, Tetsuo (National Inst. of Radiological Sciences, Chiba, Japan); Oda, Aiko; Miyahara, Sachiko; Kasida, Yosihiko; Yamada, Osami. J. Radiat. Res., 7: 134-41(Sept.-Dec. 1966).

A liquid scintillation counter was used to determine the ^{14}C content of ethanol extracted from cane sugar and sweet potatoes, of thymol extracted from Orthodon japonicum, and of menthol from Menta arvensis. Tables are presented to show results for ethanol content from 1948 to 1965, for thymol content from 1954 to 1965, and for menthol content from 1942 to 1965. Carbon-14 activity began to increase in 1957 and a peak, 80% above normal, occurred in 1963 that was caused by large scale nuclear explosions near the end of 1962. (H.L.W.)

40711 RADIOACTIVITY IN DRINKING WATER IN THE UNITED KINGDOM 1966 RESULTS. J. Brit. Waterworks Ass., 50: 33-8(Jan. 1968).

A report which gives the amounts of ^{90}Sr and ^{137}Cs found in 1966 in 19 selected drinking water supplies in the United Kingdom is summarized. The average level of ^{90}Sr in the tested river-derived supplies in 1966 was 0.60 pCi/l, omitting the Southhampton supply that contained only 0.052 pCi/l. Values for the same supplies in the previous year were 0.86 and 0.073 pCi/l, respectively. The river-derived supplies contained an average value of 0.08 pCi/l of ^{137}Cs, compared with 0.10 pCi/l in 1965. The average concentration of ^{90}Sr in the 10 impounded waters included in the monitoring program for at least the past five yr was 1.60 pCi/l for 1966. The average concentration of ^{137}Cs in 1966 was 0.41 pCi/l, compared with 0.52 for the same sources for 1965. Appreciable fractions of the ^{137}Cs in the raw waters at Leeds and Liverpool were subsequently removed during the slow sand filtration process. The average daily ingestion of ^{90}Sr and ^{137}Cs in drinking water in the United Kingdom in 1966 was estimated as 0.77 and 0.18 pCi/l respectively. The corresponding values for 1965 were 0.95 and 0.19. Results were included of some total α and total β determinations and comprehensive radiochemical analyses of three water samples. (BBB)

40712 RELATIONSHIPS BETWEEN EXPOSURE, KERMA, AND ABSORBED DOSE IN A MEDIUM EXPOSED TO MEGAVOLTAGE PHOTONS FROM AN EXTERNAL SOURCE. Batho, H. F. (British Columbia Cancer Inst., Vancouver). Phys. Med. Biol., 13: 335-46(July 1968).

The conditions under which absorbed dose can be determined from a measurement of exposure are discussed. It is shown that, for megavoltage photons, the equation $D = fX$, relating the absorbed dose to the exposure at a point, is valid on the central axis of the field only at the point where the kerma curve, K(z) vs. depth z, crosses the absorbed dose curve, D(z) vs. z. This point is expected to be at a depth slightly less than the depth of peak absorbed dose. At depths where the absorbed dose curve becomes exponential it is shown that $D = \{\beta/(\beta-\mu)\}fX$, where μ is the effective linear attenuation coefficient for the photons, and β is the effective linear energy absorption coefficient for the secondary electrons. Alternatively, $D(z) = f\{(F + z - \delta)/(F + z)\}^2 X(z - \delta)$, where D(z) is the absorbed dose at depth z and $X(z - \delta)$ is the exposure at depth $(z - \delta)$. The equation for δ as a function of μ and β is derived and approximate values of these constants are given for different megavoltage radiations. (auth) (UK)

40713 DETERMINATION OF DEPTH DOSE CURVES FOR SOFT X RAYS. Markus, Benno (Univ., Goettingen, Ger.). Strahlentherapie, 135: 25-31(1967). (In German).

The most important problems concerning soft x-ray dosimetry as well as suitable substances for phantoms are discussed. An extrapolation-ionization chamber is described, which uses a thin plexiglas entrance and exit foil. Depth dose curves were determined in the tissue equivalent phantom material M3 for 10, 29, 43, and 50 kV x rays with suitable filters (Siemens Dermopan unit with beryllium window) as well as for 50 kV radiation without filter. The results obtained were compared with those given in the literature. (auth)

40714 RECIPROCITY LAW OF RADIATION INTENSITY AND RADIATION TIME FOR BIOLOGICAL RADIATION EFFECTS. Buecker, Horst (Biophysical Space Research, Frankfurt am Main). Strahlentherapie, 135: 83-9(1968). (In German).

The reciprocity law between radiation intensity and irradiation time is quite often not fulfilled for biological radiation reactions. Possible deviations from this law were analyzed mathematically. The deviations can lead to a tolerance irradiation intensity and/or tolerance irradiation time. Conditions causing these tolerance levels are discussed. The considerations mentioned above were applied to measurements concerning the pigment effect of uv radiation. Different models are discussed for direct pigmentation with time factors greater and less than 1. (auth)

40715 RADIOACTIVE FALLOUT AND MILK. Rammell, C. G. (Wallaceville Dairy Lab., N. Z.). N. Z. J. Agr., 113: 57; 59(Dec. 1966).

The human body discriminated in favor of Ca by a factor of four to one and the cow discriminated in favor of Ca by a factor of seven to one. The net result of this discrimination was that the ratio of ^{90}Sr to Ca deposited in the bones of people through drinking milk was, on average, only about 1/30 of the ratio in the original pasture. Milk contains fewer Sr units than many other foods. Substitution of almost any other food as the main Ca source for children therefore exposed the children to a greater hazard from ^{90}Sr. It was unlikely that dangerous levels of ^{131}I would ever be reached in New Zealand dairy products, as long as atmospheric nuclear testing was not carried out too frequently in the Pacific area. However, ^{138}Cs was considered less of a hazard than ^{90}Sr or ^{131}I. In 1957 the New Zealand Department of Health was made responsible for monitoring the level of environmental radioactivity in New Zealand. The results of its work were published quarterly in reports of the National Radiation Laboratory, Christchurch. The average level of ^{90}Sr in New Zealand milk was never as high as that found in milk produced in the northern hemisphere. The level of ^{137}Cs was also lower than in the northern hemisphere. The National Radiation Laboratory examined milk from throughout New Zealand three times/week for its ^{131}I content, so that an early warning would be expected in the unlikely event of high levels being found. On this basis, the fallout danger from consuming milk and its products was negligible. (BBB)

40716 RADIATION BURDEN OF LONG-LIVED ARTIFICIAL RADIONUCLIDES IN THE ATMOSPHERE. Fox, Johannes M. (Inst. for Radiation Research, Luebeck, Ger.). Strahlentherapie, 135: 94-102(1968). (In German).

Based on worldwide data on ^{90}Sr a mean value of residence time of ^{90}Sr at groundlevel was calculated to 3.5 yrs. This value is considered to be representative for the total fallout. Based on this residence time at ground and considering the mean residence time of radioactive debris within the stratosphere, the temporal course of the radioactivity at ground level within the middle geographical latitudes was calculated for the single radionuclides of fallout and for the whole beta- and gamma-radiation. The values obtained in this way led to an estimation of the mean annual radiation dose from long-lived fallout. The result was a mean annual dose of 3.6 mrem/acre for the period 1954 to 1966 and a presumable value of 2.2 mrem/acre for the period 1967 to 1971. The part of radiation dose caused by ^{90}Sr was 16% and 37%, respectively, the part caused by plutonium was 9% and 18%, respectively. (auth)

40717 DETERMINATION OF NATURAL RADIOACTIVE ELEMENTS (U-nat, ^{226}Ra, ^{210}Pb, AND ^{210}Po) IN THE URINE OF EXPOSED PERSONS. Zsoldos, Tibor; Csovari, Sophia (Mecsek Ore-Mining Enterprise, Pecs, Hungary). Magy. Kem. Foly., 73: 228-32(May 1967). (In Hungarian).

Uranium was quantitatively precipitated with tannic acid in the presence of Ca carrier and was determined photometrically in the form of its arsenazo-III complex. By using Ba, Bi, Pb, and Te carriers, the precipitation of trace amounts of the other natural radioactive elements was also accomplished. They were determined by radiometric measurements. The method was suitable for the analysis of urine from exposed persons, and provided an estimate of the degree and nature of exposure. (JPRS)

40718 SOME PROBLEMS OF MEDICAL INSURANCE OF WORKERS WITH RADIATION DEVICES. Coseru, E.; Cristescu, C.; Stefan, M.; Teodorescu, C.; Sigal, S.; Pintilie, I.; Ceasu, V. Rev. Sanit. Mil., 63: 327-9(Mar.-Apr. 1967). (In Rumanian).

The principal dangers to workers in radiological examination rooms, particularly to their eyes, and to radar personnel are discussed. Criteria of employability and related factors are considered. (JPRS) (TSS)

40719 MEDICAL MEASURES OF PREVENTION OF SOME SPECIFIC HAZARDS OF IONIZING RADIATION, CURRENTS OF HIGH FREQUENCY, AND SPECIAL FUELS. Andries, A.;

Bergheanu, S.; Plesca, I. Rev. Sanit. Mil., 63: 320-7(1967). (In Rumanian).

Data on the protection from ionizing radiation as carried out in radiology, protection from high-frequency currents and from some chemical missile-propellants are given. (JPRS)

40720 CURRENT PROBLEMS OF PREVENTION OF DAMAGING EFFECT OF IONIZING RADIATION PRODUCED BY RADIOACTIVE SUBSTANCES. Voinea, V. Rev. Sanit. Mil., 63: 313(Mar.-Apr. 1967). (In Rumanian).

Very brief data on the utilization of a generator to produce ^{132}Te and ^{99}Mo, with comments about the possible danger to personnel are presented. (JPRS)

40721 THE EXTENT OF AEROGENIC INTRODUCTION OF ^{239}Pu INTO THE HUMAN BODY. Tarasov, S. I.; Smorodintseva, G. I.; Oreshina, A. F.; Shalak, N. I.; Yaskova, V. Z. Gig. Sanit., No. 4, 34-8(Apr. 1968). (In Russian).

Aspirated samples of the atmosphere, the lung tissue and the tracheobronchial lymphatic nodules were investigated. The kinetics of the ^{239}Pu content in the air, the lungs, and the lymphatic nodules was studied for 1964 and 1965. Hygienic assessment of a possible hazard of the aerogenic introduction of ^{239}Pu into the body of persons having no occupational contact with the isotope was carried out. (auth)

40722 THE PHARMACIST'S ROLE IN RADIOLOGICAL HEALTH. Barnett, Mark; Barletta, Francis (National Center for Radiological Health, Rockville, Md.). Amer. J. Hosp. Pharm., 24: 361-6(July 1967).

Colleges of pharmacy now offer elective courses in radioisotope technology to students; for the graduate pharmacist, intensive courses are presented at the National Center for Radiological Health of the Public Health Service, Rockville, Maryland, and at other locations. Practical instrumentation studies supplement the physical and biological courses related to the overall public health problems associated with radiation exposure. Further training may include preparation for radiation safety duties or "compounding" with isotopes; such programs are available at the National Center for Radiological Health and at Oak Ridge Associated Universities. Two programs available to develop the radiological specialist include intensive courses for state health department employees and provides grant funds to universities to support teaching staffs, provide student fellowships and secure equipment. Curricula consist of a radiation science core and a public health core with emphasis oriented in one or more areas. Pharmacists are accepted for enrollment at all schools except the engineering institutes, and most programs offer a master's degree. (BBB)

40723 STUDIES ON RADIATION DISTRIBUTION IN RATS, PHANTOMS OF RATS, GUINEA PIGS, AND RABBITS AFTER WHOLE-BODY X RADIATION BY MEANS OF LITHIUM FLUORIDE THERMOLUMINESCENCE DOSIMETRY. Roesler, Bernward; Nicht, Manfred; Reichel, Gerhard (Biological Inst., Radiation Inst., and Radiotherapy Clinic, Magdeburg, Ger.). Strahlentherapie, 135: 32-7(1968). (In German).

Radiation distribution in laboratory animals and animal phantoms in the case of whole-body X irradiation was measured by means of lithium fluoride thermoluminescence dosimetry. Compared with frozen rats, the same results were obtained with paraffin-containing rat phantoms, while different results were obtained with skeleton-free phantoms. The use of animal phantoms for such measurements can be recommended only with certain reservations. A relation between body weight and organ dose was observed with animals of the same type; such a relation cannot always be observed if different animal species are compared. Deviations were caused by differences in body proportions, body position and course of the gastro-intestinal tract. (auth)

40724 REFLECTION, SCATTER, AND ATTENUATION BY SOME BUILDING MATERIALS IN DENTAL RADIOGRAPHY. Goren, Arthur D.; Pentel, Leon (New York Univ., N. Y.). N. Y. State Dent. J., 33: 221-4(Apr. 1967).

Various building and construction and shielding materials normally found in the dental radiographic examining room were investigated to determine the ability of these materials to reflect a radiation aura. An experimental model was constructed using low density acoustical tile, intermediate density cinder and concrete block. Ionization chambers were used to measure the scatter, reflection, and attenuation. The results showed that low and high density materials both contributed a low but significant reflection radiation into the radiological examining room independent of the material density. Higher density materials significantly attenuated the x-ray beam. Larger-sized radiological examining rooms could assist in the reduction of the scatter of the radiation flux to the patient. The use of shortened 90-KVp high-speed film techniques limited the radiation flux to both patient and operator to the greatest extent. The radiological examining room should be as large as possible and contain the least nonessential (to the radiographic purpose) impedimenta as possible. (BBB)

40725 RADIOACTIVITY IN THE ENVIRONMENT: SIGNIFICANT ISOTOPES IN FOODS. Forbes, Gilbert B. (Univ. of Rochester, N. Y.). Pediatrics, 41: Suppl., 207-14(Jan. 1968).

Some information available on isotopic contamination of foods is reviewed. Only 4 radionuclides, ^{131}I, ^{89}Sr, ^{90}Sr, and ^{137}Cs, qualify under ordinary circumstances as possibly a significant hazard in foods. The first one is of importance only for brief periods following a nuclear explosion and is likely to be found only in foods which are eaten fresh. A table illustrates the recent milk levels of these 4 radionuclides during the past few years. These averages for the United States show wide regional variations, the range being 3 to 10 times the mean. The ratio $^{90}Sr/Ca$ progressively falls as the isotope proceeds through the food chain (soil → plant → man) so that human bone contains about 5% as much $^{90}Sr/g$ Ca as the soil which received the fallout. Some special situations are related, such as the fact that Alaskan Eskimos and Finnish Lapps have much higher body burdens of both ^{90}Sr and ^{137}Cs than Americans or Europeans. Moreover, certain radionuclides, such as ^{134}Cs and ^{22}Na, are present in these peoples which are rarely, if ever, found in others. The ecological reasons are explained. Generally infants and children have a higher food intake per unit body weight than the adult, so that proportionally more fallout products are consumed. Opinions as to the hazards of present dietary fallout levels are briefly assessed. (BBB)

40726 STATE LICENSURE OF X-RAY TECHNICIANS: THE EXPERIENCE OF NEW YORK STATE. Goldman, Howard L.; Cohen, Alan R. (New York State Dept. of Health, Albany). Amer. J. Public Health, 58: 528-33(Mar. 1968).

A program for regulating licensure of medical x-ray assistants to insure protection of the public in radiologic procedures is described. Periodic inspections of x-ray equipment for several years revealed that many instances of excessive exposure of patients or operators to radiation could be attributed to the poor training of operators rather than to faulty equipment. In July 1964 legislation requiring the licensure of x-ray technicians became effective in New York State. The legislation set standards for eligibility and apparently eliminated many untrained persons. As a result, the number of hospital-based schools for x-ray technicians expanded, new community college courses were developed, and further licensure was mandated in 1965 for x-ray therapy technicians and chest radiographers. (BBB) (TSS)

40727 RADIOACTIVITY IN THE ENVIRONMENT: BIOPHYSICAL FEATURES OF ISOTOPIC CONTAMINATION IN RELATION TO AGE AND SIZE. Pickering, Donald E. (Univ. of Nevada, Reno). Pediatrics, 41: Suppl., 215-22(Jan. 1968).

Prediction of probable effects of ^{131}I contamination on the fetus is examined from knowledge of major aspects of growth and function of the thyroid gland as the normal conceptus develops. Quantitative observations are reviewed that were made concerning thyroid gland structure, function, and thyroxine metabolism per se in normal monkeys (Mulatta macaque) throughout fetal life. The data provide a stepwise account of thyroid gland growth and associated changes in its microscopic anatomy and its content of iodine, monoiodotyrosine, diiodotyrosine, and thyroxine. Information concerning ^{131}I trapping and distribution within the fetal thyroid gland at specific ages is also presented. These data clearly show the complete inappropriateness of attempting to inhibit potential ^{131}I contamination of fetal thyroid glands by administering thyroid hormone to near toxic levels to mothers. It is concluded that the combined administration of thyroxine in physiological amounts, plus iodide in amounts greatly exceeding daily requirements, would be the only safe and rational approach to radiation prophylaxis in the fetus (and its mother) potentially contaminated with ^{131}I. (BBB)

40728 ROYAL DECREE CONCERNING A STATE INSTITUTE FOR RADIATION PROTECTION. pp 1739-42 of Svensk Foerfattningssamling, No. 785, Stockholm. (In Swedish).

The subject matter includes: definition of the tasks of the Radiation Protection Institute (role of the Institute as the central administrative organ responsible for all matters connected with protection from ionizing radiation, as provided for in the Act of March 14, 1958, on radiation protection; research and data collection on radiation hazards; coordinating activities of quarters concerned with radiation protection in Sweden; and supply of information); organization of the Institute; scope; and appointments to established positions. (Occup. Safety and Health Abstr.)

40729 SAFETY OF PLANTS AND HEALTH PROTECTION OF WORKERS AND THE GENERAL PUBLIC FROM IONISING RADIATION HAZARDS RESULTING FROM THE PEACEFUL USE

OF NUCLEAR ENERGY. Presidential Decree of Feb. 13, 1964, No. 185, pp 1-30 of Gazzetta Ufficiale della Repubblica Italiana, No. 95, Supplement 1st Part, Rome. (In Italian).

General provisions and definitions are followed by sections on the following aspects: coordinating, advisory and inspecting bodies; inspection of mines (contamination measurement, records and documents, medical examinations, decontamination); trade in radioactive materials; plant (permit to operate, reception tests, research reactors, storage of radioactive materials, penalties); protection of workers' health; protection of public health; and state of nuclear emergency. (Occup. Safety and Health Abstr.)

40730 ZASHCHITA OT IONIZIRUYUSHCHIKH IZLUCHENIY; SPRAVOCHNIK. (Protection Against Ionizing Radiation: A Manual). Kimel', Leonid Ruvimovich; Mashkovich, Vadim Pavlovich. Moscow, Atomizdat, 1966. 310p.

Basic data on radiations of the most widely used radioactive isotopes and mixtures of fission products, on maximum permissible levels of ionizing radiations, on protection against γ-, neutron, α-, and β-radiations, and on the effect of heterogeneities in shields on the passage of radiation are collected and systematized. For the first time, data on protection against neutrons, conversion principles for calculating fields of radiations, information on albedo γ-radiation, and questions concerning the passage of radiation through a shield with heterogeneities are considered. Domestic and foreign literature data, in addition to data obtained by the authors are included. It is designed for engineer-physicists, scientific workers, students and a wide circle of people concerned with problems of protection during work with radioactive substances and sources of ionizing radiation. Much tabular and graphic material is included. (ATD)

40731 SREDSTVA INDIVIDUAL'NOY ZASHCHITY DLYA RABOT S RADIOAKTIVNYMI VESHCHESTVAMI: OPYT SOZDANIYA KONSTRUKTSIY, METODY OTSENKI, REZUL'TATY ISSLEDOVANIY. (Means of Individual Protection for Work with Radioactive Materials: Design Experience, Evaluation Methods, and Research Results). Gorodinskii, Semen Mikhailovich. Moscow, Atomizdata, 1967. 223p.

A description of Soviet and foreign data on individual protection of persons working with radioactive materials is given. Data obtained over a long period are summarized. A description of basic designs for protection of respiratory organs and the skin of personnel exposed to various working conditions is included. Considerable attention was given to problems of evaluating various protective systems, their repair and effective employment. The book is intended for scientists, physicians, engineers, and technicians working in the field of radiation safety. (ATD)

40732 LOW-MINERAL ASH DIAPER DEVELOPED FOR STRONTIUM BALANCE STUDIES IN INFANTS. Wellman, H. N.; Kahn, B. (National Center for Radiological Health, Cincinnati). J. Pediat., 72: 108-10(Jan. 1968).

In a study of ^{90}Sr and stable Sr balances in infants (sources of the Sr and ^{90}Sr were the usual premodified milk formulas and packaged infant foods), commercially available paper diapers were found suitable for continuous collection of infant excreta for long study periods. The low levels of both stable Sr and ^{90}Sr in the excreta required that 28-day balance periods be used through the first year of life. Levels of stable Sr and ^{90}Sr in the diapers themselves were similar to those in the excreta. A paper diaper with low Sr content and low acid-insoluble residue was developed. Low Sr content was achieved with paper pulp of low mineral content such as pulp from which photographic paper is prepared. To lower acid-insoluble residue, the titanium dioxide whitening agent was excluded in the manufacture of the nonwoven fabric that held the absorbent pulp of the diaper. Strontium content of the resultant diaper was $1/10$ that and the insoluble residue $1/9$ that of the commercially available diaper. (BBB)

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Refer also to abstracts 40142, 40377, 40379, 40433, 40504, 40523, 40552, 40555, 40578, 40592, 40615, 40670, 40676, 40684, 40686, 40687, 40829, 40835–40838, 40856–40858, 40869–40873, 40877, 40878, 40889, 40897, 40905, 40922, 40930, 40965, 40969, 40971, and 40980.

40733 RADIORESTORATION EFFECT OF SOME NUCLEIC ACIDS ON AN EMBRYONIC ORGAN OF CHICKEN CULTIVATED IN VITRO. Kirrmann, Jean-Michel (CNRS, Nogent-sur-Marne, France). Compt. Rend., Ser. D, 266: 1520-2(Apr. 1, 1968). (In French).

The possibility that restoration of lesions induced by exposure to 800 R x radiation in embryonic chicken intestine cultivated in vitro can be stimulated by adding nucleic acids to the culture medium was investigated. Incorporation of ^{3}H-thymidine was used as the index of recovery of cells. The addition of DNA to the culture medium had no effect on the uptake of ^{3}H-thymidine by the irradiated intestine. The addition of RNA caused the uptake of ^{3}H-thymidine by cells of the irradiated intestine to practically double after four hours. This effect was visible in epithelial tissues, but not in mesenchymal tissues, 24 hours after irradiation. It was concluded that the addition of RNA to culture medium stimulated recovery from radiation injury. (C.H.)

40734 ADENO SCINTIGRAPHY OF THE INTERNAL MAMMARY SYSTEM. Minutoli, A.; Mastroeni, G. (Univ., Messina, Italy). Med. Nucl. Radiobiol. Lat., 10: 231-41(1967). (In Italian).

A technique is described for visualizing the lymph glands of the internal mammary system of man following the administration of ^{198}Au colloids. The anatomy of the region is briefly outlined and refers particularly to the number and topography of sternal lymph nodes found at autopsy. A good visualization of lymph nodes was almost always obtained by scintigraphy. Possible normal variants were considered and on the basis of results, possible clinical use is examined. (auth)

40735 BONE SCINTIGRAPHY WITH ^{85}Sr BIOLOGICAL FUNDAMENTALS AND CLINICAL RESULTS IN 55 CASES. d'Amico, P. Med. Nucl. Radiobiol. Lat., 10: 243-58(1967). (In Italian).

A detailed description is presented of the biological fundamentals on which bone scintigraphy with ^{85}Sr is based, and of 55 cases examined with this technique, comparing results with those obtained through radiographic examination. In 18 cases of osteoporosis there was complete agreement between radiographic and scintigraphic findings; accumulation of ^{85}Sr in these cases was always very slight. In 5 cases of Paget's disease an intense accumulation of radioisotope was observed in zones so altered as to preclude sure differentiation of secondary neoplastic damage. There was also complete agreement between radiographic and scintigraphic examinations. Only one of four benign osseous tumors was visualized (fibroma of cranial bones). Of 22 cases of suspected metastasis, 16 showed radiographic findings agreeing with the scan; examination with ^{85}Sr in four cases showed metastasis radiologically undemonstrated, and 2 cases had falsely negative results. (auth)

40736 STUDIES ON BIOLOGICAL RADIATION PROTECTION. 80TH REPORT. QUANTITATIVE RELATIONS OF CHEMICAL PROTECTIVE AGENTS. Koch, Ruprecht (Univ., Freiburg i.B.). Strahlentherapie, 134: 102-9(Sept. 1967). (In German).

The different quantitative behavior of the radioprotective effects after administration of cysteamine and histamine, reported in previous publications, were investigated by using the probit-analysis. But even such an evaluation showed clearly that, in case of cysteamine, there were quantitative relations between the concentration of the protective substance in the animal organism at the time of x-irradiation and the radiation dose. Histamine showed a different behavior. This agreed with our previously given interpretation, that in the case of cysteamine a radical disappearance- or scavenging-mechanism applied, while a pharmaco-dynamic effect applied in the case of histamine. The radiation protective effect in mice produced by serotonin was interpreted as a pharmaco-dynamic effect. (auth)

40737 PRIMARY CARCINOMA OF THE VAGINA AND METHODS OF TREATMENT. Weghaupt, Karl (Univ., Vienna). Strahlentherapie, 134: 13-20(Sept. 1967). (In German).

During the period from 1951 to 1961, 122 primary carcinomas of the vagina were observed in the Department of Gynecology of the University of Vienna. According to the stage classification (FIGO), 72 cases–58.9% belonged to the far advanced stages III and IV, and 89 patients–73% were between the 6th and 8th decade of life. A highly individual, fractionated and protracted radium-x-ray therapy was recommended as the method of choice. Of the 122 cases, 49–40.1% with primary carcinoma of the vagina were cured. There was no primary mortality during the report time, but nine women could receive only a palliative therapy. Intercurrent diseases were the cause of death in four women, and four other patients died due to a second carcinoma. Radiation damages appeared in eight cases–6.5% as fistulas (one vesico-vaginal fistula, seven recto-vaginal fistulas); the patients were already in an advanced stage of the disease. Finally, a report was presented on one patient, who was treated 15 years ago for a vaginal carcinoma while being seven months pregnant. The patient was well and the child (boy) showed a normal and healthy development. (auth)

40738 CHANGES IN THE CAPILLARY SYSTEM UNDER THE INFLUENCE OF IONIZING RADIATION AND POSSIBLE PROTEC-

TIVE EFFECTS OF TRIHYDROXYETHYLRUTOSIDE. EXPERIMENTAL STUDIES WITH THE RABBIT EAR CHAMBER. Klemm, Johannes (Univ., Munich). Strahlentherapie, 134: 31-44(Sept. 1967). (In German).

Changes in the capillary system occurring in 72 rabbits after irradiation with 1000, 2000, and 3000 R of fast electrons (6 MeV) were investigated at different time intervals after irradiation, using a rabbit-ear-chamber. The effect of different doses of trihydroxyethylrutoside on these changes in the capillary wall was studied. A clear protective effect was observed with this flavonoid. The intensity of the damage was decreased, the onset of damage was delayed, and regeneration events were accelerated. (auth)

40739 EFFECT OF HYPOXIA DURING IRRADIATION ON FOUR-DAY DEATH IN MICE GIVEN SINGLE AND SPLIT DOSES OF ELECTRONS. Alper, Tikvah; Hornsey, Shirley (Hammersmith Hospital, London). Brit. J. Radiol., 41: 375-80(May 1968).

Anesthetized mice were exposed while anoxic to single or split doses of electrons, and the values of four-day (intestinal) LD_{50} were compared with those for mice treated similarly while breathing oxygen. The values of $LD_{50/4}$ for single exposures were 2810 and 1010 rads respectively, i.e., the oxygen enhancement ratio was 2.8. When fractionated doses were given in about that ratio, the time patterns of the split-dose recovery curves referring to anoxic and oxic mice were the same. Values of the $LD_{50/4}$ were measured for 12-hour fractionation. The first doses were 1600 or 600 rads to mice breathing nitrogen or oxygen. Dose-effect curves were the same for both groups, whether the mice were breathing nitrogen or oxygen during the second series of doses. Values of the LD_{50} were 3980 and 1410 rads when both doses were given under nitrogen and both under oxygen. Thus the differences in LD_{50} for single and split doses were 1170 and 400 rads, i.e., the increments were in about the same ratio as the OER for single shots. The equal modification by anoxia of the effects of single and split doses contrasts with the markedly unequal extent of sparing by the fractionation of neutron and x ray doses. The two sets of results together strongly support the attribution of the sparing effect of fractionation on the gut syndrome to intracellular repair of sub-lethal damage. (auth)

40740 PROTECTIVE EFFECT OF HISTAMINE AGAINST LETHALITY OF MICE FOLLOWING WHOLE BODY IRRADIATION. Nakatsuka, Haruo; Shakudo, Yozo (Osaka City Univ.). J. Radiat. Res., 7: 142-5(Sept.-Dec. 1966).

The survival rate and time of a Na 2 strain of mice, exposed to lethal doses of x-rays, was found to be significantly increased after pretreatment with histamine in dosage of 1, 3, 5, 10, and 20 mg per mouse, most effective in doses of 5 mg. The optimal dose level for protection may be different in different strains of mice. As a possible mechanism of radioprotective activity of histamine the property of producing a temporary tissue anoxia was discussed. (auth)

40741 OUR RESULTS WITH THE RADIATION TREATMENT OF NON-TUMOROUS ILLNESSES. Mitrov, G.; Harbov, I. (Institut fuer Aerztliche Fachschulung und Fortbildung, Sofia). Radiobiol.-Radiother., 8: 419-22(1967). (In German).

Observations made on 7250 patients with various ailments other than tumors and who were treated percutaneously with x-ray or γ radiation were summarized. This treatment method which is simple and easily carried out under ambulatory conditions is of great clinical and social value. In the present stage of radiology, in the hands of highly qualified radiologists, the radiation burden to the organism during irradiation of limited fields with small doses is quite insignificant. (tr-auth)

40742 CANCELLATION OF THE HEPATIC SHADOW FROM PANCREATIC SCINTIGRAPHY WITH ^{75}Se-METHIONINE BY MEANS OF THE IMAGE SUBTRACTION TECHNIQUE. Ventura, Sandro; Palumbo, Renato (Univ., Perugia, Italy). Minerva Med., 59: 2513-15(May 30, 1968). (In Italian).

A new technique for cancelling the hepatic shadow from pancreatic scintigraphs obtained with ^{75}Se-methionine is proposed. One of the pictures obtained with this technique is given as an example and its simplicity is illustrated. It is suggested that this technical device be used in other applications of the scintigraphic method. (auth)

40743 LOCALIZATION IN SCINTISCANNING USING TWO ISOTOPES. Cottrall, M. F. (Inst. of Cancer Research, Sutton, Eng.); Burn, George; Field, E. O. Int. J. Appl. Radiat. Isotop., 19: 523-7(June 1968).

A mathematical study of scintiscanning using two isotopes in a subtraction mode defined the significance of this method for the delineation of overlapping tissues. (auth) (UK)

40744 THE USE OF ORAL BARIUM IN BONE SCANNING. Irwin, G. A. L. (Brunswick Hospital Center, Amityville, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 103: 432-4(June 1968).

The use of oral barium suspension prior to ^{85}Sr bone scanning is discussed. The use of barium was an aid in easily localizing residual stool in the colon, which because of its radiostrontium content, showed up as an area of increased pick-up on the scan and lead to a false positive interpretation, especially in the region of the lumbar spine and pelvis. (auth)

40745 OBSERVATIONS ON EFFICACY OF ^{32}P IN TREATING 70 CASES OF LOCAL NEURODERMATITIS. Lu, T'i-chang; Ch'u, Wan-ying; Chang, Chih-tseng. Chung Hua P'i Fu K'o Tsa Chih, 9: 297-9(Dec. 1963). (In Chinese).

The efficacy of external ^{32}P radiotherapy in treating 70 cases of local neurodermatitis, which is 75.3%, is reported. Compounding and method of application of dressing are briefly described. Normally, a bombardment of 700 microcuries-hour/cm^2 is applied first. Relationships between efficacy and disease cause, infection area, and sex are briefly analyzed. (JPRS)

40746 RADIOPROTECTIVE EFFECT OF MAGNESIUM PEMOLINE: A COMPARISON WITH PEMOLINE AND DEXTROAMPHETAMINE. Levan, Hoa; Hebron, Delano L. J. Pharm. Sci., 57: 1033-4(June 1968).

Magnesium pemoline, a central nervous system stimulant, was found to have a significant protective effect on the survival of mice following exposure to a single dose of 750 rads x radiation. Experimental results showed that this drug is more potent that pemoline alone in exhibiting this radioprotective effect, and that dextroamphetamine does not possess this property. It is suggested that magnesium hydroxide, a component of magnesium pemoline, might enhance the absorption of pemoline to produce a more significant effect than when pemoline alone [without $Mg(OH)_2$] is used. The mechanism of this phenomenon is discussed, but no explanations are offered. (auth)

40747 ^{113m}In FOR SCANNING BONE AND KIDNEY. Mishkin, Fred S.; Reese, Isaac C.; Chua, Gonzalo T.; Huddlestun, James E. (Indiana Univ. Medical Center, Indianapolis). Radiology, 91: 161-2(July 1968).

Indium-113m was examined as a possible agent for bone and kidney scanning. In the rabbit, 1 mg of ferric ion (1 ml of a solution containing 5 mg $FeCl_3 \cdot 6H_2O$ per ml) was administered intravenously followed in one-half hour by 4 mCi of ^{113m}In chloride. Scanning was performed one hour later by means of a commercially available dual 8-inch crystal scanner with a fine focusing collimator. The scan showed good localization of indium chloride in the bone and kidney. Since ferric ion was considerably toxic, it was deemed necessary that a less toxic form, or perhaps a less toxic substitute ion such as Cr^{+++} or Ga^{+++} be used in future studies. The desirable physical properties of ^{113m}In, namely, its short 1.6 hour half-life; its pure 390 keV γ emission without associated particulate emission; and its ready availability from a tin-indium generator made it a desirable agent for scanning bone and kidney. (auth)

40748 SPLEEN SCANS WITH ^{99m}Tc-LABELED HEATED ERYTHROCYTES. Burdine, John A. Jr.; Legeay, Rosemary (Baylor Univ., Houston, Tex. Ben Taub General Hospital, Houston, Tex.). Radiology, 91: 162-4(July 1968).

The use of ^{99m}Tc-labeled erythrocytes for spleen imaging offers a potential solution to many of the problems associated with presently available agents. Incubation of 4 to 5 cc of packed cells with 2 to 5 mCi of sodium pertechnetate resulted in the binding of approximately 10% of the added counts. This level of labeling efficiency was increased by an additional 8 to 12% if the cells were altered by controlled heating or sulfhydryl inhibition after tagging. Both of these manipulations produced acceptable splenic sequestration of the erythrocytes. (auth)

40749 EXPERIMENTAL STUDIES DURING RADIOTHERAPY UNDER EXCESS OXYGEN PRESSURE. Kaercher, Karl Heinz; Morita, Kozo; Moersdorf, Dieter (Univ., Heidelberg). Strahlentherapie, 134: 367-75(Nov. 1967). (In German).

The radiosensitizing effect of oxygen hypertension during radiotherapy was proved by using tumor growth curves, measurements of the oxygen partial pressure in normal and tumor tissues, by determining the total mitoses and the mitotic phases, and by measuring the content of lactate and lactate dehydrogenase (LDH) in the serum of tumor-bearing rats. A stimulating effect upon the tumor growths was not observed. (auth)

40750 NATURE OF THE RESISTANCE EFFECT FOLLOWING RADIATION. III. RADIORESISTANCE OF IRRADIATED GOATS. Waldschmidt-Leitz, Ernst; Keller, Lorenz (Heiligenberg Inst., Ger.). Strahlentherapie, 134: 422-5(Nov. 1967). (In German).

Transferring blood of irradiated goats to non-irradiated animals resulted in a radiation resistance effect that was based on the ef-

fect of two components, one of which was contained in the plasma; the other, in the formed elements. (auth)

40751 TOXICITY OF OZONE IN COMPARISON WITH IONIZING RADIATION. Veninga, Tjeerd Simon (Univ. of Groningen, Netherlands). Strahlentherapie, 134: 469-75(Nov. 1967).

Comparison of the deleterious effects of ozone and ionizing irradiation supported the view of considering ozone as a radiomimetic substance. The reactions observed in living organisms were concerned with general modifications, alterations at the cellular level and congenital malformations for which a certain predisposition appeared to be present. Concentrations of ozone as low as 0.05 ppM delivered for 1 hour prior to sublethal doses of x rays led to additive mortality in male mice. These ozone concentrations were very near to natural values. The findings justified a critical attitude to commercial ozonizers. (auth)

40752 STUDIES ON BIOLOGICAL RADIATION PROTECTION. 81. METABOLISM OF INJECTED 5-HYDROXYTRYPTAMINE IN MICE WITH REGARD TO CHEMICAL RADIATION PROTECTION. Streffer, Christian; Keck, Klaus (Univ., Freiburg i. B.). Strahlentherapie, 134: 442-51(Nov. 1967). (In German).

The metabolism of injected 5-hydroxytryptamine-2-^{14}C was investigated in several organs of the mouse. The time of investigation and the dose of the substance used were selected under consideration of the chemical's radiation protection. The extracts of the organs were investigated chromatographically and the radioactive metabolites were determined. The following substances were mainly found in the kidneys, spleen, small intestine and urine: 5-hydroxyindol-acetic acid, the 0-sulfate esters of 5-hydroxytryptamine or of the 5-hydroxyindol-acetic acid, a glucuronide as well as some unchanged 5-hydroxytryptamine. One certain metabolite, the structure of which was not determined, was mainly observed in liver tissue. The results were discussed in regard to the mechanism of 5-hydroxytryptamine as a radioprotective substance in mammals. (auth)

40753 PREVENTION OF RADIATION NEPHRITIS WITH RENAL ARTERY INFUSION OF VASOCONSTRICTORS. Johnson, Ralph E.; Doppman, John L.; Harbert, John C.; Steckel, Richard J.; MacLowry, James D. (National Cancer Inst., Bethesda, Md.). Radiology, 91: 103-8(July 1968).

In canine experiments, a renal artery infusion with epinephrine produced a marked but rapidly reversible ischemia in the kidney. This hypoxia-induced state afforded dramatic protection against the development of radiation nephritis in dogs. Therefore, the method was used in patients with surgically unresectable neoplasms in the upper abdomen. With the aid of arteriography and radioisotope renography, a minimally effective vasoconstrictive dose of epinephrine was established for clinical use. In the patients studied to date, no undue side-effects or prohibitive complications were encountered. A definitive evaluation in terms of clinical usefulness was not possible, but there was preliminary evidence suggesting a confirmation of the animal research. (auth)

40754 SHORT-TERM AND LONG-TERM RADIOPROTECTIVE EFFECT OF MAGNESIUM PEMOLINE. LeVan, H. (Univ. of Illinois, Chicago). Experientia, 24: 477-9(May 5, 1968).

The radioprotective effects of magnesium pemoline were tested in mice that were injected with doses of ~0.7 mg/kg or 70 mg/kg of the drug immediately before, one week, or two weeks before exposure to a whole-body x radiation dose of 750 R. Results showed a marked radioprotective effect of magnesium pemoline on survival of the mice. Short-term protection was shown to be independent of drug dose, but long-term protection (30 days) was more pronounced when the larger drug dose was given immediately before irradiation. (C.H.)

40755 DOSE REDUCTION FACTOR PRODUCED BY TOPICALLY APPLIED DIMETHYL SULFOXIDE. Moos, W. S.; Kim, S. E. (Univ. of Illinois, Chicago). Experientia, 24: 450(May 15, 1968).

The protective effects of dimethyl sulfoxide (DMSO) against radiation injuries were tested in mice. The tails of the mice were immersed in DMSO or in water for 15 min before exposure to doses of x radiation ranging from 700 to 950 R. The 50% survival level for the water treated mice was reached 15 days after irradiation. Only 40% of the mice treated with DMSO died 30 days postirradiation. (C.H.)

40756 METHODS OF RADIOISOTOPIC DIAGNOSTICS IN THE STUDY OF RADIATION INJURY TO KIDNEYS. Bagdasarov, M. B. Voenno-Med. Zh., No. 1, 50-4(Jan. 1968). (In Russian).

During radiation therapy of malignant neoplasms of the abdominal cavity, when the kidneys are in the irradiation zone, there is a possibility of radiation injury to the kidneys, appearing at different times after radiation therapy. The methods of radiation diagnosis are valuable tests, capable in some cases of showing impairment of kidney function and establishing the degree of completeness of the parenchyma with respect to the appearance of pathological changes in the urine. Experimental studies on rabbits were made to determine the threshold dose of radiation effects on the kidneys when the dose size, clinical appearance of radiation effect, and radioisotopic diagnosis can be compared with the pathomorphological picture of the radiation injured kidney. (tr-auth)

40757 SOLID PHASE DISC RADIOIMMUNOASSAY FOR HUMAN GROWTH HORMONE. Catt, Kevin; Niall, H. D.; Tregear, G. W. (Monash Univ., Melbourne). J. Lab. Clin. Med., 70: 820-30(Nov. 1967).

The use of solid-phase antibody in radioimmunoassay allows the isolation of bound tracer antigen to be performed simply by washing with water at the completion of the immune reaction. A method is now described for the preparation of aliquots of solid-phase antibody by coating small discs of poly (tetrafluoroethylene-g-isothiocyanatostyrene) with specific antiserum. To assay human growth hormone (HGH) antibody-coated discs are incubated in counting vials with quadruplicate plasma or serum samples diluted to give a final volume of 1 ml. Horse serum is used in all standard and unknown solutions to adjust the final serum concentration to 20 to 50 percent according to the range of values to be measured. With disequilibration and ^{125}I-HGH (100 μc per microgram), a sensitivity of 0.2 mg per milliliter of plasma is obtained in a total duration of 16 to 40 hours. Major advantages of solid-phase method are simplicity, speed, sensitivity, capacity for large volumes of sample, and the use of low specific activity ^{125}I tracer. The method was also applied to the radioimmunoassay of other proteins. Simultaneous estimation of plasma growth hormone and luteinizing hormone can be performed by the use of discs coated with a mixture of antisera to these hormones. (auth)

40758 MODERN VIEWPOINTS IN THE DIAGNOSTIC USES OF RADIOISOTOPES. Pabst, Hans Werner (Univ., Munich). Hippokrates (Stuttgart), 37: 241-51(Apr. 15, 1966). (In German).

Diagnostic applications of radioisotopes in studies of the thyroid, liver, spleen, and kidney are reviewed. Kidney function studies are presented in detail, and comparisons are tabulated between procedures and interpretations of renal tests that utilized ^{131}I-Hippuran, Hypaque, or Diodrast, and ^{203}Hg-Salyrgan. Numerical criteria for normal responses in the tests are given. Radioactive clearance procedures are compared with standard inulin procedures. A relative factor of 0.94 of the radioactive to the non-radioactive clearance procedure was demonstrated. The indications for, and the significance of, radioisotope nephrography are discussed, and differential characteristics of the several types of radioisotopic renal tests were itemized. Procedures and results of radiocardiography procedures are discussed. References cited, 56. (BBB)

40759 NEUTRON RADIOGRAPHY ALLOWS VISUALIZATION OF WET TISSUE. J. Amer. Med. Ass., 204: No. 4, 23(July 22, 1968).

Problems and potentials of neutron radiography are discussed. Its promise in medicine is great since neutron radiation is readily soaked up by hydrogen; this could be a boon in the visualization of wet tissue. Problems involved in the neutron radiography technique are dosage and development of a sensitive detector system. The limitations of low vs high energy neutrons are also discussed. (B.S.L.)

40760 ^{113m}In FOR VISUALIZING BODY ORGANS. A BROAD SPECTRUM SCANNING AGENT. Potchen, E. James; Adatepe, Mustafa; Welch, Michael; Archer, Ellen; Studer, Rebecca. Contract AT(11-1)-1653. J. Amer. Med. Ass., 205: 208-12(July 22, 1968).

Indium (^{113m}In), a generator-produced radionuclide, was useful as a protein-bound metal and a colloidal aggregate to scan the cardiac blood pool, placenta, liver, spleen, bone marrow, lung, and brain. The wide applicability and ease of preparation in addition to the physical characteristics of this radiopharmaceutical suggested that it may well be the most useful scanning agent devised to date. (auth)

40761 DETECTION OF CEREBRAL LESIONS WITH RADIOISOTOPIC SCANNING. Siber, Ferris J. (Lahey Clinic Foundation, Boston). Lahey Clin. Found. Bull., 16: 289-96(1967).

Radioactive substances such as ^{197}Hg- or ^{203}Hg-chlormerodrin, pertechnetate-^{99m}Tc, and ^{131}I (RISA) do not diffuse across the blood-brain barrier of the normal brain; the normal brain, therefore, is outlined as an inactive area. There is fairly selective isotopic localization in lesions. The blood-brain barrier breakdown may be related to neovascularity as well as changes in the permeability of endothelial and glial tissues permitting leakage

of the radioactive substance into the brain tissue. A positive brain scan is one in which a lesion is defined as an area of increased activity in one plane with a matching perpendicular collection in another plane. A positive scan has been seen in the presence of brain abscess, encephalitis, meningitis, glioblastoma, meningioma, metastatic lesions, occlusive vascular disease and resulting encephalomalacic lesions, infarction, subdural hematoma, epidural hematoma, intracerebral hematoma, contusion, and arteriovenous malformation. The brain scan may reveal a lesion that is not directly demonstrated by angiography, pneumoencephalography, or both and offers precise anatomic information regarding size, configuration, and location of intracranial lesions. The scan is not meant to replace any of the accepted diagnostic radiographic procedures but rather to serve as an innocuous screening procedure in instances of equivocal neurologic findings. The single γ energy of ^{203}Hg at 279 KV minimizes scattering and penetration, the lower energy of the β particle reduces the radiation dose, and the long half-life (45.8 days) makes this isotope convenient for clinical use. Calculations show that a dose of 10 μCi/Kg body weight gives a total body dose of 290 mR. A total dose of 700 μCi or less is administered. Also, ^{203}Hg is superior to ^{131}I-RISA because the local uptake in the region of the neoplasm is at least doubled and the uptake is faster. If low energy, short-lived isotopes such as ^{99m}Tc are used, serial scans may be obtained with less irradiation hazard. (BBB)

40762 A LABORATORY SUGGESTION: A SIMPLE METHOD FOR CONTRAST ENHANCEMENT OF RADIOISOTOPE SCANS. **Hamilton, John W. (Veterans Administration Center, Bay Pines, Fla.). Amer. J. Med. Technol., 32: 399-40(Nov.-Dec. 1966).**

A method for enhancing contrast of radioisotope scan films is described. The method uses standard Polaroid techniques for photographing the radioisotope scan, but overexposes and overdevelops the film to remove areas of low density, thus giving more contrast to the pathogenic areas of high density. (BBB)

40763 RADIOISOTOPE TEST PREDICTS PEDICLE SKIN GRAFT SURVIVAL. J. Amer. Med. Ass., 205: No. 4, 21(July 22, 1968).

A radioisotope test was developed for the determination of vascularity of pedicle skin grafts. The technique involved injection of technetium (^{99m}Tc) pertechnetate into the pedicle implantation site with a 0.5 inch scintillation crystal probe placed over the area. After a control period, an infant sphygmomanometer cuff was inflated around the graft. Following a timed period of occlusion, the cuff was released and the disappearance of radioactivity after occlusion was measured until a stable level was reached. Maximum tolerable blockage compatible with continued graft survival was then estimated. In an initial group of 44 patients, the technique successfully predicted the period of graft survival in every case. However, it was concluded that more experience was needed before ideal periods of pedicle attachment could be estimated for various operative sites, patients, age, sex, and other factors. (B.S.L.)

40764 BONE SCANNING WITH ^{85}Sr, ^{87m}Sr, AND ^{18}F. PHYSICAL AND RADIOPHARMACEUTICAL CONSIDERATIONS AND CLINICAL EXPERIENCE IN 50 CASES. Spencer, R.; Herbert, R.; Rish, M. W.; Little, W. A. (Liverpool Clinic). Brit. J. Radiol., 40: 641-54(Sept. 1967).

Simple methods of producing ^{87m}Sr and ^{18}F in a nuclear reactor, and of preparing them for injection are described. There was little to choose between these two isotopes. Strontium-87, however, had certain physiological advantages especially when scanning the pelvis. The choice of time interval is discussed. With ^{87m}Sr the best scans were obtained approximately one hour after administration. Results are reported on scans in patients that were divided clinically into three groups. First, primary neoplasms; there were eight of these. Demonstrable adjacent bony involvement in connection with a soft tissue malignant tumor (e.g., Pancoast's tumor) affected the approach to treatment. Secondly, 38 cases of metastatic bone lesions were analyzed in relation to radiographic changes. Positive scans influenced the decision concerning treatment of the primary lesion, if not already initiated. Scanning gave a more accurate and earlier assessment of radiotherapy field size than did the radiograph in both primary and secondary bony lesions. Negative scans gave reassurance to patient and clinician. The third group consisted of bony dystrophies and infective lesions. (auth)

40765 USE OF ^{18}F FOR BONE SCANNING. French, Rosemary J.; McCready, V. R. (Inst. of Cancer Research, Sutton, Eng. Royal Marsden Hospital, Sutton, Eng.). Brit. J. Radiol., 40: 655-61(Sept. 1967).

A comparative study of the use of ^{85}Sr chloride and ^{18}F as fluoride for bone scanning is reported. Measurements carried out indicate that, in general, their degree of uptake into tumors is equally good. Since ^{18}F delivers a radiation dose to bone of only $1/_{200}$ that from ^{85}Sr, greatly increased activities can be given. The optimum time for scanning with ^{18}F is about one hour following intravenous injection, when only 6% of the administered dose has been found to remain in the blood, and a further 6% has been excreted in the urine. Strontium-85 is not removed from the blood so rapidly, and 18% has been found to be present after a similar time interval. Experience of 57 ^{18}F bone scans and over 100 ^{85}Sr bone scans is reported and the ^{18}F scans are compared with the corresponding radiographs. The major disadvantage of using ^{18}F is its accumulation in the bladder, but ^{85}Sr has the corresponding disadvantage of localizing in the feces in the bowel. It has been shown that ^{18}F can be given orally, though incomplete absorption from the stomach reduces the counting rate over bone and makes bone scanning impossible in the stomach area. It is concluded that the advantages of ^{18}F far outweigh its disadvantages for bone scanning. (auth)

40766 RESTORATION OF RADIATION-INDUCED DAMAGE BY NUCLEIC ACIDS. Petrovic, Danilo (Inst. Rudjer Boskovic, Zagreb). pp 251-92 of Current Topics in Radiation Research. Vol. IV. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1968.

A review of the data on the use of nucleic acids to restore radioinduced damage is presented with interpretations by different workers. The effects of nucleic acids on the survival, reproduction, histology, function, and immunology of irradiated animals are summarized. In vitro studies on mammalian cells, plant cells, and bacteria are presented with emphasis on x-radiation effects and a brief discussion of the restoration of UV damage. The utilization of foreign DNA by cells is described. 104 references. (M.M.B.)

40767 MULTIPLE BASAL-CELL EPITHELIOMATA FOLLOWING RADIOTHERAPY OF THE SPINE. Sarkany, I.; Fountain, R. B.; Evans, C. D.; Morrison, R.; Szur, L. (Royal Free Hospital, London). Brit. J. Dermatol., 80: 90-6(Feb. 1, 1968).

Six patients are reported who had multiple tumors confined to areas of skin irradiated between 11 and 28 years previously. They had received radiotherapy for ankylosing spondylitis in five cases and lichen planus in one. The age of the patients at the time of onset of the tumors was between 42 and 55 yr. The patients could be divided into those with visible radiation damage, and those without. The three with radiation damage had all received multiple wide-field, small-dose exposures and had basal-cell epitheliomas. The total dosage to tumor-bearing skin varied between 2000 and 8875 R. In the three patients without visible radiation damage the wide-field method had not been used and the dose of radiation was lower, being between 600 and 3334 R. All three of these patients had premalignant fibro-epitheliomas and two of them had also had a solitary basal-cell epitheliomas in an unirradiated area. Skin tumors must be added to the growing number of cancers from which patients with ankylosing spondylitis may suffer as a result of previous radiotherapy. (BBB)

40768 MEASUREMENT OF TOTAL CEREBRAL BLOOD FLOW IN THE MONKEY BY EXTERNAL MONITORING OF ^{131}Cs. Weiner, Daniel E. (Univ. of Virginia, Charlottesville). Circulation Res., 21: 805-16(Dec. 1967).

A technique employing ^{131}Cs was developed, as a modification of the ^{42}K fractionation technique, which permits rapid, repeated measurement of cerebral blood flow by external isotope monitoring without jugular or carotid puncture. Cesium-131 has distribution characteristics similar to those of ^{42}K. Cerebral blood flow measurement involved determination of the peak cephalic activity of an intravenously injected bolus of ^{131}Cs by digital rate counting in a well-scintillation crystal that enclosed the head. If the entire fraction of the isotopic bolus entering the head appeared in the cerebral circulation before significant venous loss of ^{131}Cs began, the ratio of peak cephalic activity to total injected activity represented the cephalic portion of the cardiac output. Since cerebral capillaries are not very permeable to ^{131}Cs, activity remaining in the head after decay of peak cephalic activity represented uptake by noncerebral cephalic tissue, and the peak activity could be corrected to yield only the cerebral cardiac output fraction. (BBB)

40769 TREATMENT OF INOPERABLE PRIMARY AND METASTATIC CANCER OF THE LUNG BY INTERNAL IRRADIATION. Ariel, Irving M. (Long Island Jewish Hospital, New Hyde Park, N. Y.). Surg. Clin. N. Amer., 47: 1483-1505(Dec. 1967).

The average duration of life post treatment in 30 patients believed to have resectable cancer treated by ^{90}Y microspheres was 8.5 months. In 23 patients considered clinically inoperable and treated by ^{90}Y microspheres survival averaged 2.3 months.

The performance of a thoracotomy for interstitial irradiation is contraindicated in those patients who are considered inoperable on clinical and roentgenographic grounds. The average hospital stay after thoracotomy and interstitial irradiation was 12 days. Complications were minimal; there was one postoperative death. In 184 patients with bilateral pulmonary metastases from various primary sites, the results of treatment by intravenous administration of ^{90}Y microspheres with the delivery of the radioactive sources to the metastatic lung cancer via branches of the pulmonary artery are reported; 68.8% of the patients demonstrated a beneficial symptomatic response, and 31.2% showed roentgenographic evidence of shrinkage of pulmonary cancer. The irradiation dose delivered to the tumor is dependent upon the blood supply to the tumor and its histologic type. Experiments are described demonstrating the techniques whereby the intravenous administration of ^{90}Y microspheres may be used for preventing the take of cancer cells delivered to the lungs. The internal irradiation of primary and metastatic lung cancer by the interstitial and intravenous-arterial administration of radioactive isotopes appears to be a promising mode of therapy. The indications for, and the accomplishments to date, are described. (BBB)

40770 PHOTOSENSITIVITY FROM SOAP ADDITIVES. New Engl. J. Med., 278: 109(Jan. 11, 1968).

Ultraviolet-induced sensitivity to various chemical compounds, particularly those used as antibacterial agents in soaps, was reviewed. A large number of oral drugs magnified the ordinarily relatively harmless effect of uv light to a destructive force, producing photosensitivity. These drugs include tranquilizers (phenothiazines), antibacterial and antifungal agents (certain of the tetracyclines, sulfonamides and griseofulvin), hypoglycemic agents (sulfonylurea), diuretics (chlorothiazides) and antihistamines (promethazine hydrochloride). The specific wavelengths of light necessary for the initiation of this type of contact photodermatitis were in the long uv range, 320 to 400 nm. These wavelengths were usually associated with no known biologic reaction other than pigment darkening. The specific role of uv light in contact photosensitivity due to brominated salicylanilides was currently under study. In vitro findings indicated a chemical alteration in the halogenated salicylanilides after uv light exposure; these compounds underwent a homolytic cleavage of the carbon–halogen bond, creating a highly reactive compound. The unstable new compound could be reconstituted or could combine with numerous naturally occurring constituents of the skin, including proteins. This newly formed protein-salicylanilide complex might act as a complete antigen and the contact photosensitivity could be a form of delayed hypersensitivity similar to contact eczematous dermatitis. (BBB)

40771 PROTECTION AGAINST X-IRRADIATION BY SULPHYDRYL COMPOUNDS. I. STUDIES ON THE CELLULAR UPTAKE UNDER VARIOUS CONDITIONS OF INCUBATION. Zwenk, H.; Vergroesen, A. J.; Vos, O. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk). Int. J. Radiat. Biol., 13: 69-76(1967).

The uptake of various SH compounds by mammalian cells was studied. It was shown by means of ^{35}S-labeled cysteamine that the uptake depended on conditions of incubation, such as concentration, pH, and temperature. However, a quantitative correlation between extracellular-SH concentration and intracellular-SH content under various conditions could not be shown; several factors made it impossible to determine exactly the actual uptake. One of these is the fact that compounds that have been taken up by the cells during the incubation period leak out of the cells during a washing procedure. Data obtained in experiments with ^{35}S-labeled cysteamine, cystamine, cysteine, thioglycol, and glutathione showed that these compounds may not be taken up to the same extent by tissue culture cells. (auth)

40772 EFFECT OF ETHYLAMINE TREATMENT ON BARLEY SEEDS IRRADIATED BY GAMMA AND FAST NEUTRONS. Avetisov, V. A.; Valeva, S. A. (Inst. of General Genetics, Moscow). Genetika, 4: No. 5, 31-8(May 1968). (In Russian).

The effects of three mutagens on air-dried seeds of barley, γ, and fast neutrons irradiation and a chemical mutagen, ethylenimine were studied. Their action was studied both separately and in combination. The number of cells affected by chromosome aberrations in the first mitosis and the rate of chlorophyll mutations in M_2 after the mutagen treatment were used as criteria of mutation frequency. Pretreatment of seeds with ethylenimine reduced the deleterious effect of the radiation and a decrease in the number of cells with chromosome aberrations was observed; the decrease in the damage and the character of this process depended on the type of the radiation. The modifying effect of ethylenimine was much greater if the treated seeds were previously irradiated by γ than if the seeds were irradiated by fast neutrons. The additional treatment of the irradiated seeds with ethylenimine entirely eliminated the mutagenic effect of γ- and fast neutron-irradiation as determined by the chlorophyll mutation test. (auth)

40773 FLAT BEAM COLLIMATOR FOR RADIOISOTOPE SCANNING OF THE LUNG. Glaister, D. H. (Inst. of Aviation Medicine, Farnborough, Eng.). Brit. J. Radiol., 40: 670-5(Sept. 1967).

The theoretical requirements for a collimator to be used for scanning the lung during ^{133}Xe lung function studies are discussed. A multi-slot, flat beam collimator is shown to come closest to these requirements, and the construction of such a collimator using flat plates of heavy alloy, 0.02 in. thick, is described. The performance of this collimator is assessed by means of isocount and off-axis sensitivity curves, using a small source of low energy γ radiation (^{125}I). At the focal plane, 20 cm from the front face of the collimator, the response falls off to 10% across a rectangle measuring 2.2 cm high by 12.6 cm wide, and to 2% across a rectangle measuring 2.8 cm by 15.0 cm. At 17 cm from the front face of the collimator (two-thirds of the distance through the lung when set up for scanning) the vertical resolution, measured by the width of the half-peak response, is 1.2 cm under static conditions and 1.5 cm when scanning multiple sources of ^{133}Xe. Apart from some scattering of radiation the performance is little impaired when assessed by means of isocount curves constructed within a lung phantom. (auth)

40774 RADIATION STUDIES ON ISCHEMIA AND ISCHEMIA-HYPOTHERMIA OF THE RAT PAW. Reinhardt, Kurt (Peoples Hospital, Saar, Ger.). Strahlentherapie, 134: 434-41(Nov. 1967). (In German).

Paws of rats were irradiated at 3000 to 6000 R doses 15 min after application of a tourniquet; another group was irradiated under the same conditions with coincidental cooling of the paws with ice packs. A distinct increase in radiation resistance was found under both experimental conditions. The dose reduction factor was not higher than two. No differences in the dose reduction could be found by comparing both experimental investigations. (auth)

40775 THE EFFECT OF METHANDROSTENOLONE ON THE HISTOPATHOLOGICAL RADIATION LESIONS IN MICE. Jodczyk, K.; Kasprzycki, K.; Proniewski, H. (Medical Academy, Bialystok, Poland). Pol. Med. J., 5: 1295-306(1966).

The administration of methandrostenolone prior to and after the x irradiation of mice with a dose of 180 R decreased the intensity of the symptoms of radiation sickness and of the histopathologically detectable injury to internal organs. The irradiation caused maximal decrease of body weight on the 4th day. The decrease amounted to 19% in females and 12% in males. Administration of methandrostenolone both prior to and after irradiation fully protected males against the loss of body weight. The weight of females dropped less rapidly and showed greater tendency to normalization. Irradiation caused distinct decrease of leukocytosis, 40% in males and 50% in females treated with methandrostenolone (Dianabol). Administration of Dianabol both prior to and after the irradiation significantly inhibited the radiation leukopenia. The maximal drop of leukocytic count was 20% in females and 30% in males. Treatment with methandrostenolone exclusively after the irradiation only slightly decreased radio-induced leukopenia, but when given prior to irradiation, radiation leukopenia was not essentially influenced in females, but leukopenia was increased in males. A wide variety of microscopic lesions were observed in liver, spleen, gonads, thymus, and bone marrow. (BBB)

40776 DIGITAL COMPUTER PROCESSING OF RADIOISOTOPE SCINTISCAN MATRICES. Tauxe, W. Newlon (Mayo Clinic and Mayo Foundation, Rochester, Minn.). J. Amer. Med. Ass., 205: 285-91(July 29, 1968).

The digital computer constituted a tool of major importance in the processing and handling of scintiscan matrices. All data accumulated in the course of scanning, along with correct x-y orientation, were tape recorded in computer-compatible format and fed into a high-speed digital computer for reconstitution of the scan matrix. Improvement was manifested by finding more filling defects, defining areas totally void of activity, providing better resolution, and obtaining greater detail. Of perhaps even greater importance was the ability of the computer to quantitate activity in terms of actual γ rays per character. Since it handles low count rates better than the photoscan, it provided a combination of thyroid-uptake data and scan information on usual thyroid-uptake doses (5 μc in the cases presented). These scans were cheaper than the usual photoscans, both in the amount of electronic equipment needed and in the cost of the film, film processing, and storage. (auth)

40777 TUMORS SEEDED WITH ^{51}Cr. J. Amer. Med. Ass., 205: No. 5, 25(July 29, 1968).

Chromium-51 seed implants were evaluated for use in radiotherapy of tumors in patients that had received maximum therapy from external beam radiation and radium. Eighteen of 25 patients showed excellent or favorable response; necrosis and hemorrhage were seen in three. An implant gun was used to deposit the seed in each cubic centimeter of the tumor. The advantages of using chromium-51 as an internal γ-ray source are discussed. (B.S.L.)

40778 NON-RANDOM KARYOTYPE PROGRESSION IN CHRONIC MYELOID LEUKAEMIA. Muldal, S. (Christie Hospital and Holt Radium Inst., Manchester, Eng.); Taylor, J. J.; Asquith, P. Int. J. Radiat. Biol., 12: 219-26(1967).

A case of chronic myeloid leukemia was reported, which in the past had been given a therapeutic dose of ^{131}I for thyrotoxicosis. Cytogenetic studies performed shortly before death showed a stem-cell chromosome number 49($2PH_1$ and $2C_3$) and a sufficient number of 47 and 48 cells to suggest an evolutionary pattern. The possible role of the ^{131}I therapy was discussed. (auth)

40779 CONTINUOUS IRRADIATION OF P388F LYMPHOMA IN VITRO SENSITIZATION BY 5-IODO-2'-DEOXYURIDINE. Fox, Margaret; Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 12: 251-64(1967).

P388F lymphoma cells in vitro were exposed to non-cytotoxic concentrations of IUdR (5-iodo-2'-deoxyuridine), either as a 30 min pulse, or continuously for 20 days. Both treatments caused an increase in sensitivity (increase in doubling time) to continuous irradiation. Sensitization, reduction in extrapolation number, to acute doses of 300 kVp x rays was demonstrated after 16 days growth in low IUdR concentrations (up to 0.28 μM). Populations given 30 min treatments (5.6 μM IUdR) and subsequently grown in normal medium were also more sensitive to acute doses of x rays. There was again a decrease in extrapolation number with no change in the D_0 value. This increased sensitivity was still demonstrable in two of the treated populations after 20 days' growth and in a third after 30 days' growth in normal medium. Sensitization, after 30 min treatments, was not due to a change in the relative proportions of the stages of the cell-cycle as shown by the rate of increase of labeled cells and labeled mitoses. (auth)

40780 CLINICAL APPROACH TO NEUTRON THERAPY. Easson, E. C. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 175-206 of Current Topics in Radiation Research. Vol. III. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons Inc., 1967.

Obstacles to effective radiotherapy are discussed and those that hold greatest promise for early improvement are indicated. Among the topics discussed is the problem of the connotations of therapeutic ratio. The basis for the concept, the definition, and methods for improvement of the therapeutic ratio are included. The relation between oxygen and radiation sensitivity, in terms of the oxygen enhancement ratio and oxygen phenomena in solid tumors and normal tissue is also discussed. Included is a review of the physical considerations attendant to, the dosimetry for, and the biological considerations to be taken in neutron therapy. An assessment is made of the state of the use of neutron therapy and admonition given concerning relevance, criteria and ethics of trials and treatments. The paper concludes with a brief look at physical and radiobiological questions relating to neutron therapy that remain unanswered. (E.R.B.)

40781 DEVELOPMENT OF CELLULAR RESISTANCE TO IRRADIATION. Jakobsson, Per; Littbrand, B.; Modig, H.; Revesz, L. (Karolinska Sjukhuset, Stockholm). Nord. Med., 77: 798-801(June 22, 1967). (In Danish).

Cells of the ELD ascites tumor were subjected to serial irradiation by sublethal x-ray doses in the course of 23 intraperitoneal transfers in mice. Clonal sublines, isolated from the serially irradiated population, were studied together with the parental line with regard to radiation sensitivity and various cellular characteristics, such as cell volume, chromosome number, DNA content, and concentration of protein-bound and nonprotein-bound sulfhydryl groups. When irradiated under anoxic conditions, the cell lines showed considerable variation in radiosensitivity. Increased radioresistance was found to be associated with a duplicated genome and/or increased cellular concentration of the nonprotein-bound sulfhydryl groups in relation to protein-bound sulfhydryl groups or DNA. When irradiated in the presence of oxygen, the radiosensitivity of the different cell lines was similar. The interrelation between the content of protein-bound and non-protein-bound sulfhydryl groups in biopsy material from recurrent cervical cancer in Ra-treated patients showed a similar change in comparison with primary tumors as was seen in the radioresistant sublines of the serially irradiated mouse tumor in comparison with the radiosensitive parental line. Selection of cells with increased level of intrinsic radioprotective thiols was considered as a possible mechanism for the development of recurrent tumors. (BBB)

40782 EFFECT OF 5-FLUOROURACIL ON RESISTANCE OF E. COLI 15 CELLS TO ULTRAVIOLET RADIATION AND ON POLY U-DIRECTED IN VITRO INCORPORATION OF L-PHENYLALANINE-^{14}C. Varkonda, Stefan; Slezarikova, Viera; Sedliakova, Milena (Biological Inst., Bratislava). Biologia (Bratislava), 23: 206-10(1968).

Incubation of uv-irradiated cells of the strain E. coli 15 dependent on thymine, histidine and uracil with 5-fluorouracil resulted in a significant increase of survival rate by cells. Intensity of this posttreatment effect was limited by the time in which the analog was supplemented to the irradiated cells. When using ribosomes from the cells incubated with 5-fluorouracil, a considerable inhibition of L-phenylalanine-^{14}C incorporation in vitro has been observed. It is supposed that the inhibition of proteosynthesis in vivo and vitro was caused by unproportional composition of ribosomes in which a considerable part may be represented by incomplete FU-particles. An increase of cell resistance in this case was probably caused by another mechanism as is the postponement of postirradiation DNA synthesis. (auth)

40783 EFFECT OF ^{60}Co GAMMA IRRADIATION ON BLOOD PRESSURE AND CEREBRAL BLOOD FLOW IN THE MACACA MULATTA. Chapman, Paul H.; Young, Robert J. (School of Aerospace Medicine, Brooks AFB, Texas). Radiat. Res., 35: 78-85(1968).

Sixteen Macaca mulatta monkeys were exposed to a single 2500-R dose of cobalt-60 gamma irradiation at a dose rate of 500 R/min. Immediately following irradiation there was precipitous decline in cerebral blood flow. The initial decline was followed by a period of partial recovery within 20 to 30 minutes, with a subsequent slower secondary decrease in cerebral blood flow thereafter. Alterations in cerebral blood flow were accompanied by parallel changes in systemic blood pressure. Following irradiation there was a phase of immediate hypotension followed by transient partial recovery at 20 to 30 minutes. Contributing to the observed decrease in cerebral blood flow following irradiation was an apparent impairment of the normal regulatory function of the cerebral vasculature in maintaining adequate blood flow. The cerebral blood flow decline was of a degree that might be expected to produce impairment of normal CNS function. It occurred at a time during which behavioral incapacitation has been observed following supralethal doses of ionizing radiation, suggesting a causal relationship. (auth)

40784 BRONCHIAL PATENCY AND AERATED SPACE ASSESSMENT BY SCINTISCANNING. Taplin, George V.; Poe, Norman D.; Dore, Earl K.; Greenberg, Al (Univ. of California, Los Angeles). Lahey Clin. Found. Bull., 16: 297-312(1967).

The basic concepts, test agents, techniques, and equipment for performing inhalation lung scintiscans are described. The pathophysiological significance of abnormal scan findings is demonstrated in controlled animal experiments. The results of combined radioaerosol inhalation-perfusion scanning using ^{99m}Tc-albumin (200 to 300 mCi) in more than 500 patients are presented for both types of scintiscanning procedures in a wide variety of cardiopulmonary disorders. The perfusion scan has greater diagnostic value for the early detection of both minor and major pulmonary embolism. Both scintiscanning techniques are practical methods for evaluating regional pulmonary function. Scans, angiograms, chest films, and bronchograms are not competitive procedures. Each enhances the value of the other. Radioaerosol inhalation scanning has fewer applications than perfusion scanning, and its diagnostic value is limited to the detection of partial or complete bronchial obstruction. Inhalation scanning gives a better estimate of pulmonary function in obstructive bronchopulmonary disease than does perfusion scanning. Both types of scanning procedures are valuable adjuncts to radiography and pulmonary function tests whenever assessment of regional arterial perfusion and airway patency is needed. The potential diagnostic value of combined inhalation-perfusion scanning is discussed, and specific clinical conditions are defined. (BBB)

40785 METHOD OF ASSAYING X-RAY DEVELOPER ACTIVITY. Pentel, Leon; Hyman, Milton (New York Univ., N. Y.). Oral Surg., Oral Med., Oral Pathol., 24: 777-80(Dec. 1967).

Reduction of patient exposure during dental radiography required consistently well-developed radiographs. Properly exposed film, inadequately developed, could produce radiographs that were useless for the retrieval of diagnostic information. Such failures inevitably resulted in the re-exposure of the patient to ionizing radiation. The time loss and the dual effort expended were not especially significant in the case of the single film, but with the full series these and the additional patient irradiation

comprised a serious price for such practices. A method to assure appropriate developer activity was described. The method used test film and standards for film-density comparison. A pre-exposed test film was used to ascertain developer integrity or activity. This pre-exposed film (exposure factors were stated) was processed in the manner prescribed for the clinical radiograph by time-temperature development for the particular developer used. The film was then rinsed and fixed for the conventional period, usually twice the time necessary for clearing. The pre-exposed film was finally compared with a set of standard or reference films. The density or tone selected for pre-exposure of the test film was based on a consistently observed density in visually judged and satisfactory clinical radiographs (2.0 density, as measured on the Eastman Kodak Model 1 densitometer). This tone was intense enough that only complete development in an appropriately active developer would provide the full tone. (BBB)

40786 NEW TECHNIQUE FOR DETERMINING CARDIAC OUTPUT WITH USE OF A MINIATURE ESOPHAGEAL SCINTILLATION DETECTOR. Hernandez, Antonio Jr.; Goldring, David; Ter-Pogossian, Michel; Eichling, John (Washington Univ., St. Louis). Circulation, 35: 55-60(Jan. 1967).

A miniature scintillation detector was designed for use with ^{99m}Tc. It was inserted into the esophagus and under fluoroscopic vision positioned so that radioactivity emitted from ^{99m}Tc in the blood in the descending aorta could be detected; a time-concentration curve was recorded and the cardiac output was determined. Simultaneous determinations of 20 cardiac outputs by the isotope-dilution method with the esophageal scintillation counter probe and the dye-dilution technique were performed in 10 dogs. There was good correlation between the 2 methods. Among the technical advantages of the isotope-dilution method over the dye-dilution method were avoidance of arterial puncture, requirement of only one sample of venous blood, great ease of procedure, and ability to repeat determinations of cardiac output with a minimum of manipulation and trauma. (BBB)

40787 THE EFFECT OF THE MEDULLARY AUTOTRANSPLANTATION ON THE SURVIVAL RATE IN MICE WITH AN ACUTE RADIATION DISEASE. Aleksandrov, S. N.; Galkovskaya, K. F. (Central Research Roentgeno-Radiological Inst., Leningrad). Vop. Onkol., 14: No. 4, 79-82(1968). (In Russian).

Transplantation of autologous bone marrow was found to be ineffective in mice irradiation in a dose of 600 R γ (^{60}Co) but increased the life span in mice irradiated in a dose of 900 R. This effect, in combination with streptomycin injections, resulted in longer survival of animals given 1100 R. (auth)

40788 IRRADIATION FOR TREATMENT OF CARCINOMA OF THE LUNG IN INDIGENT AND PRIVATE PATIENTS. Scott, W. P. S. Med. J., 60: 486-93(May 1967).

Effectiveness of orthovoltage (250-KV) x-ray therapy and ^{60}Co γ irradiation of lung cancer in 400 patients was compared. In indigent patients treated with orthovoltage radiation, opposing fields were generally used with a third lateral port added to increase the tumor dose to/or beyond 4000 R. With sufficient protraction of 8 to 19 weeks, tumor doses were increased to the 5000 to 6000 R levels. In indigent patients treated with ^{60}Co, opposing fixed fields at 70 cm distance were used to give 1000 R/week (vs 600 R per week with orthovoltage therapy) to 5000 to 6000 R levels. Private patients were treated with basically the same technic with ^{60}Co except treatment distances were 50 or 60 cm. Some patients were given combined treatment. In terms of mean survival time and percentage of 2-yr survivals, the effects of dose level were analyzed. Although there was superiority in both the mean survival time and the percentage of 2-yr survivals in the group treated with combined x-ray and ^{60}Co irradiation, it was probably due to fractionation, protraction, increased tumor dose, and selection of patients. The superiority of combined therapy with superficial x rays and γ rays is attributed to the concept of tissue tolerance of two wavelengths of ionizing radiation energy being more satisfactory than a total dose of a single wavelength. (BBB)

40789 RADICAL RE-IRRADIATION FOR CARCINOMA ARISING FROM THE PREVIOUSLY IRRADIATED LARYNX. Wang, C. C. (Massachusetts General Hospital, Boston). Laryngoscope, 77: 2189-95(Dec. 1967).

Cases that illustrate the usefulness of irradiation of carcinomas that arose following irradiation of the larynx are reported. Satisfactory results were encountered in retreatment of carcinoma of various sites of the body, such as the nasopharynx, oropharynx, and uterine cervix. Radical re-irradiation calls for meticulous techniques. Supervoltage radiation, such as 2-MeV Van de Graaff x rays or ^{60}Co γ radiation, assured skin-sparing and adequate cancerocidal dose effects. In order to minimize further injury to the adjacent normal tissues, the smallest possible portals, but with adequate margins, were used. For limited glottic carcinomas, a portal size of 3 × 3 cm was usually adequate. Prolonged fractionation had minimized tissue reaction and radiation injuries to the organs. A tissue dose of 6000 to 7000 R in 7 to 8 weeks' time is required for control of a disease. Even with extreme caution, the risk of tissue necrosis still exists, but it should be fully accepted and minimized. (BBB) (TSS)

40790 FUNDAMENTALS AND POTENTIALITIES OF RADIOTHERAPY. Holsti, Lars R. (Univ. Central Hospital, Helsinki). Duodecim, 83: 223-32(1967). (In Finnish).

Radiobiologic principles underlying radiotherapy are reviewed, with 23 references. The fundamental direct and indirect actions of ionizing radiations on cell components and the concept of DNA as the target molecule are considered. Cell survival curves obtained in vitro and in vivo are reproduced. The influence of oxygen on the radiosensitivity of turmoil tissue at low oxygen tensions is examined. Growth curves of a rat fibrosarcoma are compared for 4000 rad (250-KV x rays) given to anoxic tumor, 2000 rad given to rats breathing air, 4000 rad given to rats in air, and 2000 rad given to rats in high pressure oxygen (4 atm abs). Theoretical survival curves for mixed populations of well-oxygenated and anoxic cells, and the influence of tumor size and anoxia on the theoretical dose of radiation required for tumor eradication are also examined. General effects of radiotherapy on a highly anaplastic tumor and on a 50% differentiated tumor are compared. Survival curves for normal and malignant mouse cells proliferating in vivo, which may be used to predict the dose required to destroy the proliferating capacity of all cells in the tumor, are shown. Effects of different fractionation regimes are shown for 2 types of cell population (fast-growing normal tissue and slow-growing cells) are shown for: treatment every other day, longer interval treatment, and treatment every third day. (BBB)

40791 EFFECTS OF SULFHYDRYL COMPOUNDS AS RADIATION PROTECTIVE MATERIALS IN COMBINATION WITH FRUCTOSE. Fochem, Kurt; Michalica, Werner; Picha, Engelbert (Univ., Vienna). Strahlentherapie, 134: 279-83(Oct. 1967). (In German).

The radioprotective effects of Reducdyn (a combination of N-acetyl-homocysteine-thiolactone with cysteine and fructose) was investigated in healthy rats and mice as well as in tumor-bearing animals. The good radioprotective effect, that was described by others, was again confirmed. The radioprotective effect decreased by one-half in the case of tumor-bearing animals. This was probably caused by the tumor itself. Some authors believe that the radiation sensitivity of the tumor decreases with the prophylactic application of this substance prior to irradiation, but this could not be confirmed in an animal experiment. (auth)

40792 EFFECTS OF A NICOTINIC ACID DERIVATIVE ON THE RECOVERY PROBABILITY AFTER IRRADIATION. Scherer, Eberhard; Kaufmann, Horst; Piaszek, Lothar; Osmialowski, Georg (Univ., Muenster, Ger.). Strahlentherapie, 134: 263-71(Oct. 1967). (In German).

Based upon investigations that showed an influence of Complamin on the radiation reaction, it was attempted to investigate directly a change in the recovery course after x irradiation due to Complamin. A change of the recovery rate was not observed in white mice after a single whole-body x irradiation. Moreover, the increase in radiation resistance by Complamin described by others could not be reproduced clearly. In vivo investigations of the recovery of Ehrlich ascites tumor cells of the white mouse after a single x irradiation of the host showed a prolonged depression of mitosis and a delayed recovery to the pre-irradiation number of mitoses when Complamin was administered after irradiation. A conclusive explanation for this phenomenon cannot be given at the present time. (auth)

40793 THE INFLUENCE OF SOME SULFHYDRYL COMPOUNDS ON γ-RAY-INDUCED INACTIVATION AND REVERSION TO PROTOTROPHY IN E. COLI B FIL- CITRUL-. Stern, M. G.; van Dillewijn, J.; Blok, Joh (Inst. for Radiopathology and Radiation Protection, Leiden. National Defence Research Organization, TNO, Amsterdam. Univ. of Amsterdam). Mutat. Res., 5: 349-57(May–June 1968).

A study was made of the influence of cysteamine (β-mercaptoethylamine), S,2-aminoethylisothiourea, monothioglycol (β-mercaptoethanol), and cysteine on inactivation and mutation induction in Escherichia coli B fil- citrul- irradiated in nitrogen with ^{60}Co γ rays. All the compounds afforded protection against inactivation, but when they were added immediately before irradiation no protection was observed below about 10 krad. After 20 min pre-irradiation incubation with the compounds only cysteamine showed this effect. All the compounds appeared to protect against inactivation and against mutation induction to the same extent. (auth)

40794 STUDIES ON BIOLOGICAL RADIATION PROTECTION. 83RD REPORT. PROTECTIVE EFFECTS OF 5-HYDROXY-

TRYPTAMINE ON PARTIAL-BODY IRRADIATION. Streffer, Christian; Langendorff, Hanns; Allert, Utz (Univ., Freiburg i. B.). Strahlentherapie, 135: 76-82(1968). (In German).

The protective effect of 5-hydroxytryptamine against x rays was investigated in mice. After whole-body irradiation, the dose reduction factor (DRF) was 1.70 for the $LD_{50/30}$; in the case of splenectomized animals it was 1.67. After irradiation of the trunk, the DRF was 1.13; in this case, there was no significant dose increase of the $LD_{50/30}$ by a prophylactic-administration of the amine. When the head was irradiated, the administration of 5-hydroxytryptamine was effective (DRF = 1.37). In regard to the survival time of the mice, a parallelism between head and whole-body irradiation could be observed. The results obtained were discussed in regard to the mechanism of the 5-hydroxytryptamine action for radiation protection. (auth)

40795 DIAGNOSIS OF PLACENTA PRAEVIA BY PHOTOSCANNING WITH ALBUMIN LABELED WITH ^{99m}Tc. Nelp, Wil B.; Larson, Steven M. (Univ. of Washington, Seattle). J. Amer. Med. Ass., 200: 148-52(Apr. 10, 1967).

The maternal radiation exposure from a 500 μCi dose of ^{99m}Tc-labeled albumin is ~0.025 R to the blood and 0.003 R to the total maternal body. Because of the lack of transfer of the material into the fetus, the total fetal blood dose is in the range of 0.007 R with a total-body dose below 0.005 R. For initial evaluation of ^{99m}Tc-labeled albumin, placental transfer studies were carried out by injecting trace amounts of the labeled material into patients during labor from ½ to 28 hr prior to delivery. The studies indicated that 3% or less of the injected radioactivity was transferred to the fetus. Based on these considerations, the radiation exposure to the fetus after injection of scanning doses of ^{99m}Tc-labeled albumin is as low or lower than that resulting from any of the other radiographic or isotopic methods used for localizing the placenta. (BBB)

40796 COMPUTER TECHNIQUE FOR INVESTIGATING THE RATIONALIZATION OF SCINTILLATION SCAN READING. Evans, M. R.; Sweeney, J. W. Meth. Inform. Med., 6: 24-7(Jan. 1967).

A computer program is being assembled to aid in the rationalization of interpretation of thyroid scintillation scans. Each lobe is contoured at levels derived from the standard deviation of the count rate within the lobe; for each area of increased or decreased isotope uptake, its size, location, and statistical description are given. Some quasi-independent program parameters were left free for experimental variation to help determine the settings which best approximate the observer's eye. The count rates received by the detector are recorded digitally, comprising an image matrix. The image is smoothed by forming a matrix convolution that transforms each element of the image. (BBB)

40797 ALTERATIONS OF THE VESSEL WALL IN THE CAPILLARY BED AFTER IRRADIATION WITH FAST ELECTRONS: EXPERIMENTAL STUDY OF THE PROTECTIVE SUBSTANCE TRIHYDROXYETHYLRUTOSIDE (THR) BY MEANS OF THE RABBIT'S EAR CHAMBER. Klemm, K. J. (Univ., Munich). Bibl. Anat., 9: 207-13(1967).

Functional disorders and characteristic changes of the vascular wall were observed in the granulation tissue in the rabbit ear chamber after irradiation with fast electrons at 1000 R doses and higher. The effect of trihydroxyethylrutoside (THR) on these changes was studied. During and immediately after irradiation, pronounced hyperemia was observed within the chamber. The terminal vessels were dilated and an increased influx of leukocytes was noted. These changes occurred with the three different radiation doses used (1000, 2000, and 3000 R). The threshold seemed to be below 1000 R. After 1000 R the changes nearly disappeared within 15 to 20 hr. After 2000 R there was no return to normal conditions in the vessel. With doses of 1000 R and upwards, edema of the endothelial cells of the capillary wall was seen. The cell boundaries protruded into the lumen and spread in the direction of the basement membrane. Functionally, narrowing of the capillaries impeded blood flow. Following irradiation with 2000 and 3000 R the changes were more marked, and there were foci of necrosis, decomposition of vessel walls, and rupture with hematoma. Whereas with 1000 R the regions of vascular defects showing sprouting of new vessels during the following four or five days, local regeneration was absent after 2000 or 3000 R. Thrombi penetrated the interstitial space, destroying the basement membrane. An increase in the number of macrophages and histiocytes was seen. After irradiation the initial alterations were similar in control and THR-treated animals, but in subsequent evolution the reactions of the capillary wall cells and of the basement membrane were less intense after 1000 R. The THR-treated animals showed acceleration of reversal of irradiation effects, as well as of new formation of vessels. However THR did not completely prevent necrosis after 3000 R but definitely delayed it. (BBB)

40798 INFLUENCE OF CYSTAMINE AND CYSTEAMINE ON THE SURVIVAL OF MICE INJECTED BY THE INTRAPLEURAL ROUTE WITH AN EHRLICH TUMOR IRRADIATED IN VITRO. Haot, J.; Lennes, G. (Univ., Liege). Bull. Cancer, 54: 285-96 (July-Sept. 1967). (In French).

The radioprotective effect of sulfhydryl compounds on mice undergoing whole-body irradiation was studied; R3 mice and their hybrids (R3 × C57Bl)F1 that were given an intrapleural injection of neoplastic cells from an ascitic Ehrlich tumor were used. Rapid death followed. Mortality was evaluated after a period of six to 10 days on the basis of the number of cells received (from 4×10^4 to 5×10^6). The two sexes of R3 mice were equally affected. Mice of the F1 strain survived slightly longer than R3 mice. A fixed quantity (5×10^6) of neoplastic cells was irradiated in the presence of cystamine or cysteamine and injected into the mice. A dose of 2000 R of x rays inhibited development of intrapleural tumors and increased survival of animals. Addition of cysteamine to the ascitic fluid 15 min before irradiation partially annulled its effects, reducing the survival time of the animals as compared with that of the mice injected with the irradiated ascites fluid and no radioprotective agent. Under these same experimental conditions, cysteamine produced no effect. (BBB)

40799 THE RELATION BETWEEN BLOOD FLOW IN AN ISOLATED MUSCLE MEASURED WITH THE ^{133}Xe CLEARANCE AND A DIRECT RECORDING TECHNIQUE. Kjellmer, I.; Lindbjerg, I.; Prerovsky, I.; Toennesen, H. (Univ. of Gothenburg, Sweden). Acta Physiol. Scand., 69: 69-78(Jan.-Feb. 1967).

The ^{133}Xe clearance technique was compared with directly metered blood flow in the isolated gastrocnemius muscle of cats at different flow levels between rest and maximum exercise dilatation. Whether the ^{133}Xe was applied by close intra-arterial injection or intramuscularly, the clearance curve had a multiexponential course. This was attributed partly to local variations of the affinity of the tissues to the gas but mainly to an uneven perfusion of the muscle. When the first phase of the clearance curve was approximated by a monoexponential curve and was taken to represent blood flow a significant correlation to metered flow was found. With intra-arterial injections the calculated flow amounted to an average of 93% of the drop counter flow while after intramuscular injections it only averaged 62%. The difference in results was ascribed to the different microcirculatory conditions created by the two modes of injections. It was concluded that the ^{133}Xe clearance technique could give valuable information about the local circulation provided the limitations of the method were considered. (BBB)

40800 EFFECT OF ^{60}Co RADIATION ON EXTRACTION HEALING IN THE MANDIBLES OF DOGS. Shearer, Harrie T. (Univ. of Iowa, Des Moines). J. Oral Surg., 25: 115-21(Mar. 1967).

The optimal time to begin ^{60}Co radiotherapy in the postextraction period was determined. Multiple extractions and alveolectomy were performed in both sides of the mandibles of dogs. Fractionated ^{60}Co radiotherapy was given to one side of the mandible after intervals of 3, 7, 10, 14, or 21 days postsurgery. The time at which the radiation was started in the postextraction stage did not significantly influence the final healing result. In dogs, fractionated irradiation was started as early as 3 days postsurgery with the expectation of complete and uncomplicated healing. There was some evidence that early postoperative irradiation retarded the formation of new bone; however, this effect was not serious enough to alter the final healing result. When therapy was started 21 days after surgery, no radiographic or histologic evidence to suggest retardation of bone formation was noted. (BBB)

40801 PRE-RADIOGRAPHIC DEMONSTRATION OF BONE METASTASES WITH ^{85}Sr PHOTOSCANNING. Wirtanen, George W.; Cameron, John T.; Briggs, Russell C. (Univ. of Wisconsin Medical School, Madison). Wis. Med. J., 65: 469-71(Dec. 1966).

The use of ^{85}Sr to locate bone metastases prior to their detection by radiography is discussed. Photoscanning with ^{85}Sr localizes early secondary osseous deposits and allows a rational therapeutic approach, whether the therapy be of a radical nature or one of palliation. Photoscanning with ^{85}Sr is a reliable examination and offers additional information not available on conventional radiographs. This radioisotope, along with ^{18}F and ^{87m}Sr offers another tool to the clinician in the diagnostic approach to malignant disease. (BBB)

40802 OXYGEN THERAPY AS AN ADJUVANT TO RADIOTHERAPY AFTER MASTECTOMY: OBSERVATIONS ON OXYGEN BY NASAL CATHETER AT ATMOSPHERIC PRESSURE. Thompson, Roy H. (Woman's Hospital, Cleveland). Ohio State Med. J., 63: 201-3(Feb. 1967).

Tumor tissue is relatively avascular and therefore becomes relatively more sensitive to radiation when its available O_2 supply is increased. This is a selective action as the sensitivity of the

host tissue with its normal blood supply is not affected. Oxygenation and irradiation must coexist within seconds. The phenomenon of O_2 enhancement may result from the fact that a photon of sufficient energy can free an electron from an H_2O molecule resulting in ionization and instability of the molecule. Freely available O_2 increases this process by a factor approaching three over ionization occurring in an anoxic state, or because of the metionic effect. A photon might disrupt a bond in a molecule of DNA within the chromosome. It has been observed that these breaks usually heal within minutes. In the presence of O ions, a reaction occurs preventing this healing process, and thus chromosomal duplication is prevented. The O_2 effect is enhanced in low ionization radiations in a response ratio of almost 3 to 1. Orthovoltage and supervoltage therapy machines seem to have an advantage if combined with 100% O_2 even at atmospheric pressure, provided adequate dosage is delivered to the diseased tissue. The arterial O_2 content increases by about 2 more volumes % for each atmosphere increase in pressure. (BBB)

40803 TREATMENT OF CARCINOMA INVOLVING THE FLOOR OF THE MOUTH, INFERIOR ALVEOLUS AND MANDIBLE. Shaw, Henry (Royal Marsden Hospital, London). J. Otolaryngol. Soc. Aust., 2: 11-17(Mar. 1967).

A total dosage of 6000 to 7000 R was usually required. Small tumors of 2 cm or less were treated with Ra needle implant alone. Larger tumors were treated with external irradiation by telecobalt to the primary lesion and upper neck fields. If satisfactory, treatment was completed with a Ra implant. The complications that occurred included postoperative edema that persisted for several weeks (though it almost always resolved in time provided that infection was kept to a minimum), infection and hemorrhages, and irradiation necrosis. Much distress arose from excess mucositis or true ulceration in the mouth if technical errors in dosage or shielding were made. Deeper necrosis of soft tissue was rare although it occurred in the tongue substance after needling. Ra implants produced some superficial sequestration of the lingual surface of the mandible. This was very painful and difficult to detect in its early stages. Separation and removal of the sequestrum was curative. Necrosis of the ramus or body of the mandible was rare and probably indicated an error in dosage. It developed via unhealthy tooth roots or infected sockets where extractions followed radiation. It was extremely difficult to arrest once established. (BBB)

40804 DATA-AVERAGING TECHNIQUES IN RADIOISOTOPE SCANNING. Christie, James H.; MacIntyre, William J. (Case Western Reserve Univ., Cleveland). Lahey Clin. Found. Bull., 16: 327-35(1967).

Conventional scanning techniques average the data and thus reduce the random effect of statistical fluctuations only in the single direction of detector traverse. While the increments between the traverse lines can be made much smaller than the spatial resolution of the collimator, true two dimensional averaging in both x and y axes of scanner traversal should be done. A diffuse pattern made by taking a radiograph of an aluminum truncated cone of the desired size can easily be made to any size or intensity distribution by varying the size and shape of the truncated cone. The overall size of this mask or pattern should be consistent with a collimator design. For high resolution collimators, such as used in thyroid scanning, patterns 1 cm in dia are used, while for low resolution collimators such as those employed in brain scanning a pattern size of 3 cm is used. Even at low counting rates, the standard deviation of density with averaged dots is barely perceptible. The averaging technique offers the possibility of actually delineating organ structure and internal configuration. This, however, is not possible unless rigid attention to the methodology is maintained. It is necessary in this technique to analyze no less than 10,000 counts/in.^{2} in the areas of maximum counting rate, a total difficult to obtain with the limitations of radioisotope dosage and the pressure of time. If tumor identification is merely required, there is no need to attain the high counting rate densities necessary for on-line averaging. (BBB)

40805 EXPERIMENTAL STUDIES ON BLOOD PROTEIN AND IMMUNOGENICITY OF ^{32}P-IRRADIATED ANIMALS. RADIOPROTECTIVE EFFECTS OF SEROTONIN. Szabo, Stefan; Krepsz, Ivan; Lukacs, Ecaterina; Kapusi, Anton; Csoegoer, Stefan; Reichel, Carol; Mody, Eugen (Univ., Tirgu-Mures, Rumania). Strahlentherapie, 135: 63-8(1968). (In German).

Internal irradiation caused by the administration of 1 mCi of ^{32}P/kg body weight resulted in strong displacements in the fractions of the serum proteins, glyco-proteins and lipoproteins in rabbits. A decrease of the albumin fractions and an increase of some globulin fractions were observed. The total glyco- and lipoproteins were increased. This displacement was significantly decreased by the administration of serotonin in daily doses of 25 mg/kg each for 10 days. Intraperitoneal injection of ^{32}P (120 μCi/100 g) decreased the production of agglutinating and hemolizing antibodies in rats that were immunized with sheep erythrocytes. Serotinin (1.5 mg/100 g daily for 10 days) also decreased this suppressing effect. It was confirmed that serotonin exerted a radioprotective effect even in the case of internal irradiation with radionuclides. (auth)

40806 SIMULTANEOUS COMPARATIVE PERIPHERIC OXYMETRIC AND RADIOCIRCULOGRAPHIC EXAMINATIONS WITH THE HUNGARIAN 4-CHANNEL-RADIOCIRCULOGRAPH. Horvath, M.; Ludvigh, K.; Sardy, O.; Horvath, E. (Staatliche Herzkrankenhaus Balatonfuered, Hungary). Atompraxis, 14: 249-53(June 1968). (In German).

The four-channel radiocirculograph made in Hungary by EFKI is discussed. The conformity of the clinical diagnosis after thorough examinations of 100 patients with the results obtained by the oxymetric dye dilution and the R^{131}ISA isotope dilution methods, respectively, in case of simultaneous peripheral injections into the cubital vein is identical in 83% of the cases. If the diseases are accompanied by shunt circulation, the efficiency is diagnostically somewhat higher, while with diseases without shunt circulation, it is somewhat lower. In conclusion, theoretical and practical advantages of simultaneous radiocardiography and oxymetry are pointed out. (auth)

40807 A UV DOSIMETER FOR MEDICINAL, BALNEOLOGICAL, AND BIOCLIMATIC PURPOSES. Grasnick, K. H.; Kaiser, H. Z. Meteorol., 19: 15-21(1966). (In German).

An instrument that enables a physician to assess the adequate dosage in the effective application of UV radiation is described. A CdS crystal photoresistance served as the radiation receiver; due to its temperature sensitivity, it was enclosed in a thermostat. Glass and liquid filters made possible the arbitrary measurement of either uv radiation between 280 and 400 nm (G–uv) or of radiation between 280 and 320 nm (uv–B). The Lambert cosine law was sufficiently satisfied by the interposition of a Larche sphere sealed with a quartz calotte. The current supplied by the photoresistance reached the integration motor by way of a linear, two-stage direct current amplifier; the motor was characterized by a linear revolutions value in the 0 to 7.5 V range. An impulse counter with preselection possibilities was controlled by means of the contact stud of the motor via an intermediate relay. The electromagnetic impulse-counter mechanism functioned from the preselected number towards zero where it released an acoustic signal. The entire apparatus was calibrated by means of a uv standard lamp. (ATD) (TSS)

40808 EMERGENCY RADIOGRAPHY WITH RADIOISOTOPES. Voinea, V.; Herscovici, H.; Georgescu, A. Rev. Sanit. Mil., 63: 9-13(Jan.-Feb. 1967). (In Rumanian).

Data on radiography with ^{144}Ce, ^{60}Co, ^{192}Ir, and ^{170}Tm are presented. Briefly discussed are ^{197}Hg, ^{125}I, and ^{147}Pm. The apparatus used is described. (JPRS)

40809 DIGITAL DATA ACQUISITION SYSTEM FOR NUCLEAR MEDICINE. Clifton, John S. (Washington Univ., St. Louis); Potchen, E. J.; Hill, Rexford L. Int. J. Appl. Radiat. Isotop., 19: 505-9(June 1968).

A nuclear medicine data acquisition system has been developed which interfaces directly with a digital computer and thus affords the opportunity for multiple forms of clinical nuclear medicine data to be computer analysed. The versatility of this approach is demonstrated by two examples. Data recorded from multiple head probes following an intracarotid injection of ^{133}Xe was used in a computer program for the rapid calculation of regional cerebral blood flow using standard washout techniques. A second example is the application of computer analysis to dual label rectilinear scanning using subtraction techniques. These examples substantiate the opinion that this data acquisition system can provide a valuable adjunct for a clinical nuclear medicine laboratory using both kinetic and static data acquisition systems. (auth) (UK)

40810 NEW STEREO FLUOROSCOPY SYSTEM REDUCES RISK, TIME, AND DISCOMFORT. Can. Hosp., 43: 96-7(Oct. 1966).

The x-ray tube described is similar to that used in stereo radiography. In the new system, however, a stationary optical polarizer is located just above the objective lens of the image intensifier tube, and a second rotating polarizing filter, synchronized to the firing of the x-ray beams, is placed before the viewing mirror. Depth perception with the unit is on the order of 1/8 in. This can be enhanced by use of optional equipment which oscillates the x-ray tube at varying speeds, thus increasing or decreasing the angle of convergence to exaggerate or diminish the perception of depth. (BBB)

40811 EFFECT OF RADIATION PLUS ENDOTOXIN ON THE WALKER 256 RAT CARCINOSARCOMA. Contreras, Ma. de los Angeles (Univ. of Rochester, N. Y.). Proc. Soc. Exp. Biol. Med., 124: 948-53(1967). (UR-49-779).

A dose of 1500 R x radiation to rat Walker carcinosarcoma 256, followed by a sublethal dose of endotoxin, produced routinely a condition that gross and histological study suggested was an infarct involving all or nearly all tumor tissue. Tracer studies with intravenously administered ^{131}I-labeled-antibody to rat fibrin showed a pronounced localization of radioactivity about the periphery of treated tumors with no radioactivity in the central portions of the tumor, a picture consistent with a lack of blood circulation there. Endotoxin or x ray, administered alone, at the same doses, produced no obvious effect on tumor histology or antibody localization. (auth)

40812 LINEAR ACCELERATOR IN THE TREATMENT OF CERVICAL CANCER: A DECADE OF EXPERIENCE. McLennan, Charles E.; McLennan, Margaret T.; Bagshaw, Malcolm A. (Stanford Univ., Palo Alto, Calif.). Amer. J. Obstet. Gynecol., 98: 675-80(July 1, 1967).

Complications of irradiation and clincial results are presented for 168 patients treated with the linear accelerator. From 1956 to 1965, supervoltage x rays from the linear electron accelerator, plus Ra, were used to treat invasive cervical carcinoma. A homogeneous dose of at least 6000 rad was given to the entire pelvis. About 60% lived at least 5 yr after treatment, and the survival rate for those with Stage I tumors was 83%. A high incidence of transient intestinal symptoms noted previously persisted despite recent efforts to diminish the amount of irradiation to the sigmoid colon. In the past four yr, about ¾ of the patients reported some degree of diarrhea during treatment, compared with an incidence of 84% in the first 100 patients. Six of the 100 women treated earlier required either a colostomy or resection of an intestinal segment damaged by radiation. Of the 68 treated in the period 1962 to 1965, eight (12%) required colostomies, two were hospitalized for conservative management of intestinal obstructions, and four treated for severe late proctitis. Efforts to diminish the incidence of radiation injuries to sigmoid colon and small bowel were not successful and it was conceded that intensive supervoltage therapy in excess of 5000 rad leads to higher injury rates. The intestinal injuries did not appear to be predictable and very little actually is known about the mechanism of production of sternotic lesions in the recto-sigmoid area. Although an appreciable incidence of radiation proctitis and sigmoiditis might be acceptable if this meant a greater salvage of patients with advanced lesions, this has not been the result thus far, and the collective morbidity of those with radiation injuries is becoming serious for the patients and for surgeons. (BBB)

40813 RADIOIODINE IN TREATMENT OF CONGENITAL HEART DISEASE WITH SEVERE PULMONARY HYPERTENSION. Varnauskas, E.; Korsgren, M.; Olander, R. (Univ. of Gothenburg, Sweden). Brit. Heart J., 29: 838-42(Nov. 1967).

Radioinduced hypothyroidism in nine patients with congenital cardiac anomalies causing cyanosis, eight also with severe pulmonary hypertension, and one with equal pressures in both ventricles, treated with large doses of radioiodine is described. The level of hypothyroidism was subsequently controlled by substitutional therapy to keep the improvement constant and to avoid myxedema. Functional capacity, determined clinically, improved considerably. A dose of 20 mCi ^{131}I was given orally to all patients except one who received 12 mCi. In two patients an additional dose of 20 mCi was given a few months later. Only one patient did not improve, but died six months later of congestive heart failure. It is concluded that the use of radioiodine in the treatment of cyanotic patients with severe pulmonary hypertension is effective in ameliorating cardiovascular symptoms, including hemoptyses. There was no evidence that the induction of a well-controlled hypothyroidism is accompanied by adverse effects on the cardiovascular system. (BBB)

40814 SYMPOSIUM: PATHOLOGY OF RADIATION INJURIES: SUMMARIZING REMARKS. Takeuchi, Tadashi (Hiroshima Univ.). Acta Pathol. Jap., 17: 357-60(Aug. 1967).

Clinical and experimental studies of radioinduced pathological changes are reviewed. Recently 12 new cases of atomic bomb casualties on which autopsies were performed within three to eight days after the exposure to the atomic bomb at Hiroshima were reported. The pathologic findings of these cases are characterized by a severe alteration in the endocrine system. This is a new and significant finding in both the fields of atomic bomb pathology and endocrinology. It is believed that the radioelements, induced by the neutron radiation outside the body, might have been inhaled and then acted as internal emitters. This finding may be related to that of a considerable number of leukemia patients found recently among persons who entered Hiroshima city shortly after the atomic bomb detonation. They were not exposed to the explosion, but presumably had inhaled radioelements induced by neutrons from the explosion. Leukemia in bombing survivors is characterized by the high incidence of the chronic myeloid type. Acute leukemia would probably originate from a hypoplastic focus in abnormal bone marrow, whereas chronic leukemia might be of multiple origin. In the latter case, coexistence of cessation of maturation and hypoplasia might provide a pathogenic condition for leukemia. Some related tissue culture and animal studies were also surveyed. (BBB)

40815 SYMPOSIUM: PATHOLOGY OF RADIATION INJURIES. Watanabe, Susumu (Hiroshima Univ.). Acta Pathol. Jap., 17: 309-10(Aug. 1967).

The medical implications of the biological effects of the atomic bomb explosions, that occurred over the cities of Hiroshima and Nagasaki 21 yr ago, are discussed. Many points relating to chronic radiation injuries remain to be clarified. In general, effects of external γ irradiation were studied to a greater extent than effects of neutron irradiation and internal irradiation. It was not until 10 yr later when the hydrogen bomb explosions in the Bikini test area caused accidental injuries to Japanese fishermen that attention was directed to the effects of acute internal irradiation. Some investigators have tried to estimate the effects of neutron radiation as well as γ radiation in relation to the atomic bomb explosions over Hiroshima and Nagasaki, and these studies have indicated that neutron radiation played a large role in causing injuries to atomic bomb victims. More attention has recently been directed to this problem. The necessity of extensive statistical analyses and experimental studies to supplement the clinical investigations in atomic bombing survivors is emphasized. (BBB)

40816 LUCHEVYYE PORAZHENIYA KOZHI. (Radiation Diseases of the Skin). Zadorozhnyi, Boris Akimovich; Zvyagintseva, Mariya Vasil'evna. Kiev, Zdorov'ya, 1966. 173p.

The pathogenesis and the clinical and diagnostical aspects of skin diseases caused by ionizing radiation are presented. Sources and types of ionizing radiation used for therapeutic purposes are briefly reviewed, and the most efficient modern methods of prophylaxis and treatment of ionizing radiation diseases are described. The book is intended for physicians and advanced medical students. (ATD)

40817 ^{99m}Tc BRAIN SCANS. Lanski, J. D. (Chicago Coll. of Osteopathy). J. Amer. Osteopath. Ass., 66: 996-7(May 1967).

The introduction of ^{99m}Tc as a tracer to obtain brain scans represents a significant advance, since the substances used previously, including human radioiodinated serum albumin, ^{203}Hg, and ^{74}As are not entirely satisfactory based on their poor concentration in tumor tissue, some diffusion across the blood brain barrier, and amount of radiation exposure of the patient. The search for a more suitable compound eventually led to ^{203}Hg as a substitute for human radioiodinated serum albumin. Mercury-203 has a single 0.28-MeV photopeak as compared to 0.36 MeV (87%), 0.64 MeV (9%), and 0.72 MeV (3%) for ^{131}I. This single 0.28-MeV photopeak for ^{203}Hg minimizes the problems of scattering penetration which are encountered with ^{131}I. The physical half-life of ^{203}Hg is 45 days which is not entirely favorable, but when tagged with a diuretic (Neohydrin) it is rapidly excreted from the body. About 50% of the dose is excreted in eight hr; however about nine or 10% of the dose is retained in each kidney with a long effective half-life of 28 days. The radiation dose delivered to the kidneys is high and is estimated from 70 to 150 rad with an intravenous dose of 750 μCi. Because of this radiation dose a search for a more suitable compound was necessary. Technetium-99m offers the following advantages: short physical half-life (6½ hr), no initial β emission, an optimum single γ emission of 140 keV, minimal radiation dose to the patient, larger administered dosage may be employed, greater statistical accuracy due to higher counting rate, and improved diagnostic information. Technetium-99m accumulates in tumor tissue, areas of infection, within the blood vascular system, and in areas of infarction. Normal tissue does not concentrate the isotope to an appreciable extent. (BBB)

40818 SOME ASPECTS OF RADIATION LEUKEMOGENESIS. Watanabe, Susumu (Hiroshima Univ.). Acta Pathol. Jap., 17: 311(Aug. 1967).

A survey made from 1946 to 1966 on the prevalence of leukemia among persons exposed to atomic bombing in Hiroshima is reviewed. An abrupt increase in incidence of leukemia among the Hiroshima survivors was first recognized in 1947, two yr after the detonation. The high incidence persisted until 1959, having its peak incidence in 1950 and 1951. It has gradually declined for the past few years. The mortality of leukemia has followed a similar pattern with the incidence. More than 80% of the leu-

kemic individuals were exposed to the atomic bomb radiation within 2000 m from the hypocenter, indicating a definite relation between incidence and radiation dose received. The mortality from leukemia developing among the survivors exposed within 5000 m from the hypocenter was 4.3 times as high as that of the mean among all Japanese or nonexposed individuals in Hiroshima. An increased incidence of chronic myelogenous leukemia predominates over that of other types. (BBB)

40819 PATHOLOGY IN THE EARLY STAGE OF THE ATOMIC BOMB IRRADIATION. Miyake, Masashi (Tokyo Univ.). Acta Pathol. Jap., 17: 312-16(Aug. 1967).

Experiments on doses of neutron-induced internal radioactivity are reported and interpreted in terms of pathologic findings in persons exposed to atomic bombing. ICR/JCL female mice were exposed to a neutron flux and the induced radioactivity of the whole body and of the major organs was measured. The neutrons were produced from the reaction $^{9}Be(d,n)^{10}Be$ when a deuteron accelerated by a Van de Graaff accelerator hit a Be target. Induced radioactivity in the biological tissue was derived mostly from the thermal neutron capture reaction. From the whole-body γ-ray spectra of mice after neutron irradiation, it was evident that only the three elements ^{24}Na, ^{38}Cl, and ^{56}Mn should be taken into consideration in the neutron-induced radioactivity. Calculation of the tissue-absorbed dose based on these data showed that the dose from both β and γ rays reached 0.027 rad per rad of irradiated neutron dose. Similar results were obtained from the analysis of the induced radioactivity in man in several accidents. The radiation dose received by the atomic bombing victims consisted of the primary radiation from the atomic bomb itself and that from several kinds of secondary sources that may have been negligible so that the radiation damage in autopsy material may be interpreted as due only to the primary γ irradiation and neutrons. Some autopsy data relating to acute injury after the bombings are reviewed and interpreted on this basis. (BBB)

40820 INSTITUTE OF MEDICAL RADIOLOGY AT THE SCIENCE TOWN OBNINSK. Tadzar, Isak (Univ. of Skopje, Yugoslavia). Nukl. Energ., 3: No. 6, 35(1966).

Impressions gathered at the science town-Obninsk, 100 km South of Moscow, are presented. There exist no published data concerning this brand-new science town of 50,000 (3,000 of whom are scientists). One of the scientific complexes is the Institute of Medical Radiology (IMR) with 1,800 workers in the experimental section and some 1,200 in the clinical-medical section 7 miles away. A mixed team of physicists, engineers, designers, and others work in about 30 interconnected departments and laboratories having at their disposal some 45,000 laboratory animals. A special stable can handle 15,000 radiocontaminated animals, and the section for dog experiments can carry out simultaneous experiments on 250 dogs. The clinical section consists of three blocks with over 500 beds. (JPRS)

Radiation Effects on Animals

Refer also to abstracts 40504, 40518, 40523, 40525, 40537–40541, 40552–40555, 49558, 40561–40563, 40569, 40579, 40581, 40584, 40587, 40588, 40593, 40595, 40601, 40604, 40616, 40626, 40627, 40631, 40640, 40643, 40645, 40646, 40649, 40651, 40652, 40668, 40669, 40674, 40675, 40678, 40684, 40689, 40723, 40727, 40736–40740, 40749–40756, 40766, 40767, 40769, 40770, 40774, 40775, 40777–40779, 40791, 40792, 40794, 40797, 40803, 40805, 40811, 40813–40815, 40818, 40819, 40976, and 40981.

40821 (JPRS-44070) PROBLEMS OF THE BIOPHYSICS, BIOCHEMISTRY, AND PATHOLOGY OF ERYTHROCYTES. Frank, G. M.; Poetova, V. T. (eds.). Translation of pp 216-33; 349-51 of Voprosy Biofiziki, Biokhimii i Patologii Eritrotsitov, Nauka [Science] Publishing House, Moscow, 1967. 28p. CFSTI.

Separate abstracts were prepared in three papers translated from the Russian language. (C.H.)

For abstracts of individual papers see: 40822–40824.

40822 (JPRS-44070, pp 1-9) RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST NEUTRONS. Gorodetskii, A. A.; Kirichinskii, B. R.; Shur'yan, I. M. Translated from pp 216-22 of Voprosy Biofiziki, Biokhimii i Patologii Eritrotsitov, Nauka [Science] Publishing House, Moscow, 1967.

The characteristics of the biological action of fast neutrons are reviewed, with emphasis on the effects of LET and density of ionization produced by α particles, γ radiation, and protons formed by the interaction of fast neutrons with biological tissue. Factors that influence the value of the RBE of fast neutrons are summarized. It is pointed out that a comparative study of biological action of different types of radiation requires radiation conditions where the absorbed energy from the radiation is distributed approximately evenly in the volume being irradiated. Results are reported from studies on the survival rate of rats exposed to fast neutrons in which the orientation of the animals to the neutron beam caused a variation in survival rate that varied from 17 to 90%. Results are also reported from a comparative study of the RBE of fast neutrons, x radiation, and β particles from ^{32}P on the morphological composition of peripheral blood, erythrocyte resistance, optical density of hemoglobin solutions, and methemoglobin content of blood of rabbits and rats following exposure to $LD_{50/30}$ doses. It was concluded that the hematopoietic system of the animals reacted to fast neutrons to a greater degree than to a biologically equivalent dose of β or x radiation. (C.H.)

40823 (JPRS-44070, pp 10-18) BIOLOGICAL ACTION OF LASER RADIATION. Gorodetskii, A. A.; Kirichinskii, B. R.; Evdokimov, I. R. Translated from pp 222-9 of Voprosy Biofiziki, Biokhimii i Patologii Eritrotsitov, Nauka [Science] Publishing House, Moscow, 1967.

A method for dosimetric measurements of ruby laser radiation is described. The method consists of using an objective with a controllable aperture to photograph on movie film a transparent diffusion plate illuminated by the radiation of the laser. By changing the opening of the objective, it was possible to plot regularly changing darkenings and to devise a curve for the dependency of darkening upon the logarithm of illumination intensity. The method was used to study the stability of laser radiation, the absorption of laser radiation in biological materials, and the influence of staining of tissue samples on amount of absorbed radiation energy. Results are reported from studies on the effects of focused radiation of a ruby laser on stained and unstained slides of human blood. The restricted areas of the blood smears on which the laser beam acted showed sharply outlined spots corresponding to beam diameter. Destruction of erythrocytes, but not of leukocytes, was noted in unstained blood smears and in stained smears both erythrocytes and leukocytes in the irradiated field disintegrated. It was concluded that the coagulating action of the pulsed focused radiation was intensified in the presence of natural or artificial pigments. Measurements of the electron paramagnetic resonance spectra of both pigmented and white skin of guinea pigs and rabbits following exposure to a pulsed ruby laser indicated the occurrence of free radicals was related to the presence of pigment compounds. (C.H.)

40824 (JPRS-44070, pp 19-23) STATE OF THE STROMA OF ERYTHROCYTES IN RADIATION SICKNESS. Serebrennikova, I. A.; Avraamova, T. V. Translated from pp 229-33 of Voprosy Biofiziki, Biokhimii i Patologii Eritrotsitov, Nauka [Science] Publishing House, Moscow, 1967.

Changes in the content of total protein, nitrogen, cholesterol, and phospholipids of the erythrocyte stroma of rabbits were measured during a 30-day period following whole-body exposure to 1,000 R x radiation. Profound changes in the protein-lipid complex of the stroma were noted. The relation of the findings to the elevated hemolysis of erythrocytes and the development of anemia during radiation sickness is discussed. (C.H.)

40825 (N-68-16163) FURTHER INVESTIGATIONS OF THE COMPLEX EFFECT OF IONIZED RADIATION AND ACCELERATIONS ON THE ORGANISM AS RELATED TO SPACE FLIGHTS. Antipov, V. V.; Davydov, B. I.; Panchenko, E. F.; Saksonov, P. P. Translated for National Aeronautics and Space Administration, Washington, D. C., from Russian. 11p. (NASA-TT-11397). CFSTI.

Permissible irradiation doses during exposure to space flight factors, are evaluated, with emphasis placed on the role of recovery processes in the irradiated organism's reaction to critical accelerations. Data obtained from animals exposed to various doses revealed that there are common patterns in the reactions of irradiated animals to extreme accelerations and repeated irradiation. Experimental data were extrapolated to obtain man's tolerance for extreme accelerations at different irradiation doses. In evaluating the extrapolation, it was determined that at doses of 50 to 90 rem (roentgen equivalent, man) human tolerance of accelerations after exposure to such doses would apparently not differ appreciably from that of healthy individuals for a period of 200 days after irradiation. (STAR)

40826 (ORO-657) SEMIANNUAL PROGRESS REPORT ON AGRICULTURAL RESEARCH, JULY 1–DECEMBER 31, 1966. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Sept. 1967. Contract AT(40-1)-Gen-242. 123p. Dep. CFSTI.

Progress in research is reported for the period of July 1 to December 31, 1966 at the Agricultural Research Laboratory operated jointly by the AEC and University of Tennessee. Separate abstracts were prepared on seven sections of the report

dealing with prenatal and reproductive studies, early and late effects of radiation, and plant nutrition and soil chemistry studies. Other sections not included in the abstracts deal with laboratory herd health, tissue cultures, and pathological studies. (E.R.B.)

For abstracts of individual chapters see: 40516, 40827–40831, and 40952.

40827 (ORO–657, pp 3-10) PRENATAL STUDIES. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Included in this section of the report are studies on radioinduced somatic changes in the fetus, and the effects of placental transfer of radioisotopes on fetal development. In the former study, cattle, sheep, and swine were exposed to ^{60}Co γ rays during gestation and the effects of this whole-body exposure on the fetus were determined. At the higher doses (300–400 R) abnormalities were evident in the bones of the new born offspring. No apparent effect was seen on the abortion rate. In the latter study, pregnant rabbits were injected with ^{125}I and at various gestational stages, only negligible amounts were found in fetal tissues. However, when ^{131}I was injected, the fetal thyroid content rose to 69% of the maternal dose by the 22nd day of gestation. Data on radioiodine uptake by fetal pigs are nearing completion. (E.R.B.)

40828 (ORO–657, pp 11-17) REPRODUCTION. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Progress is reported on studies of the effects of radiation on reproductive biology of miniature swine. A report is also included on the status of the lifetime reproduction herd studies. Results are presented on the effects of ^{137}Cs γ rays on follicular development in swine. It was shown that other factors must also be considered in determining the effects of radiation on reproduction. Data are presented on the status of the herd used in the lifetime radiation studies. This herd was established to observe the effects of irradiation on fertility; growth, performance, and viability of progeny; latent pathological responses in survivors; and performance of progeny by sire groups. (E.R.B.)

40829 (ORO–657, pp 18-34) LATE EFFECTS. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Results presented in this report are divided into three sections; late effects of irradiation in large animals (burros), late effects of γ rays on work performance of shetland ponies, and tumorogenesis in rats. The first study is reported under the following topics; effects of whole-body cobalt-60 γ rays on survival of burros, effects of whole-body mixed γ and neutron radiation from an atomic device on surrival of burros, effects of protein content of diet on whole-body cobalt-60 γ radiation effects on burro foals, effects of whole-body neutron irradiation on burros, effects of whole-body mixed γ and neutron radiation from an atomic device on survival and incidence of uterine tumors in swine, and a comparison of radium and ^{90}Sr toxicity in sheep. The second study was concerned with the effects of whole-body exposure of shetland ponies to cobalt-60 γ rays on their ability to work. Ancillary physiological studies were also conducted. The third study involved the injection of irradiated plasma into normal rats and determination of the incidence of tumors as compared with the incidence in control rats. Data indicate that tumorogenesis is hormone dependent in the rats studied. (E.R.B.)

40830 (ORO–657, pp 35-45) EARLY EFFECTS. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Results are reported from four different experiments. The first set of data deal with radiation effects on tissue and organ transplants and tolerance in naturally chimeric dizygotic twin cattle. The second set of data deal with the end products in urine and blood of whole-body cobalt-60 γ-irradiated animals. The third experiment was set up to determine the effects of γ radiation on the replication of DNA in cultured leukocytes from swine. Ancillary studies included establishment of reliable tissue culture techniques for a variety of animal tissues, and determination of the relation between DNA synthesis and cell phase in leukocytes from swine. Finally, results are presented from the histopathological analysis of tissues obtained from autopsies on irradiated sheep and cattle. (E.R.B.)

40831 (ORO–657, pp 46-64) NUTRITION. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Results are presented on the effects of whole-body cobalt-60 γ irradiation or γ and β emission by ^{144}Ce–^{144}Pr on the absorption and retention of ^{89}Sr, ^{45}Ca, and ^{99}Mo in cattle, sheep, and swine. A collateral study of ^{144}Ce–^{144}Pr radiotoxicity in sheep was also undertaken. Data are also presented on the uptake and distribution of ^{131}I in dairy cattle. Thyroid evaluations were made in an attempt to relate PBI and TSR values to ^{131}I content of thyroid. Correlations between thyroid uptake and time following administration of ^{131}I were investigated to determine thyroid irradiation dose rates. The effects of dietary protein and feeding method on zinc absorption by calves were investigated using ^{65}Zn as a tracer. The effects of ^{131}I on growth of chicks were studied as was the effect on egg production in pullets. Autoradiographic studies were done to determine the uptake and distribution of ^{45}Ca and ^{89}Sr following administration to chicks. Special concern was given to deposition in the bones. The biological half-life of ^{45}Ca and ^{89}Sr was also determined in Corturnix and bobwhite quail immediately after birth. (E.R.B.)

40832 (RLO–2049-1) EFFECTS OF IRRADIATION, TEMPERATURE, AND OTHER ENVIRONMENTAL FACTORS ON SALMONOID EMBRYOS. Progress Report. Welander, Arthur D. (Washington Univ., Seattle. Lab. of Radiation Ecology). June 8, 1968. Contract AT(45-1)-2049. 27p. Dep. CFSTI.

Graded, single doses of x rays were administered to four embryological stages of Chinook salmon at different temperatures. Daily observations were made of mortalities and development. Smear preparations of kidneys of salmon were made for chromosome studies. Eggs from a trout hybrid (Salmo gairdnerii) were incubated to eyed stages at 14° and 16°C. They were subjected to single x ray doses of 21 R, 81 R, and 203 R. Methods for analysis of length and weight of fish are described and results are tabulated. It was noted that the control group reared in warmer water when compared with that of the colder water was approximately 18% larger in length and 50% in weight. The growth period for both groups was 108 days. The effect of x radiation in stimulating growth in length and weight of the fry was much greater in the colder groups than in the warmer ones at every stage of development. The trends in the warmer water groups are less apparent than in the colder groups, but there appears to be an abrupt growth stimulating effect at the lowest dose administered at each stage. The largest lengths and weights attributed to x radiation stimulation, as well as the lowest mortalities, were found in the ambient temperature groups at low doses. (H.L.W.)

40833 (UCSF–34-P-41-18) AGE AND VULNERABILITY TO X-RAYS. Wood, David A. (California Univ., San Francisco. Medical Center). Apr. 1968. Contract AT(11-1)-34. 9p. Dep. CFSTI.

A summary of the results of research on radioinduced intercapillary glomerulosclerosis prior to 1967 is presented. Current studies on neonatally irradiated mice indicate the presence of specific antiglomerular antibodies in the kidneys. Intercapillary glomerulosclerosis was studied in normal aging and x-irradiated beagles. The role of lymphoid tissues in x-radioinduced intercapillary glomerulosclerosis in mice was investigated. It was found that the disease was more severe in animals receiving a single dose of 500 R at birth when the thymus was shielded than those in the group receiving the same dose with the lower extremities shielded. Germinal centers in the thymus of neonatally irradiated mice after splenectomy and multiple x-ray exposure of the peripheral lymphoid tissues were investigated. The effects of daily intraperitoneal administration of interferon on the course of spontaneous and radioinduced intercapillary glomerulosclerosis in mice were studied. Ferritin-labeled antibody studies were conducted with normal and x-irradiated mice. Studies were begun on capillary structures of organs other than the kidney. (H.L.W.)

40834 EFFECT OF WHOLE-BODY X-IRRADIATION ON CORTISOL-INDUCED GLYCONEOGENESIS IN LIVERS OF ADRENALECTOMIZED RATS. Yago, Nagasumi; Kobayashi, Shigeru; Ichii, Shogo (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 7: 167-73(Sept.-Dec. 1966).

The effect of whole-body x-irradiation of half-lethal (650 R) and lethal (1000 R) doses on the biosynthesis of liver-glycogen induced by cortisol was studied in adrenalectomized rats. The animals were fed ad libitum or fasted for 24 hours prior to whole-body x-irradiation and received cortisol (3 mg per 100 g body weight) in a single intraperitoneal injection at 24 or 48 hours post-irradiation. The liver-glycogen was determined at 6 hours after the cortisol injection. The amount of cortisol-induced liver-glycogen in irradiated rats was diminished to 60% of the controls. The degree of inhibition of cortisol-induced glyconeogenesis was independent of both the fed and fasted conditions at the time of whole-body x-irradiation or the length of starvation period after the exposure to x rays. (auth)

40835 LONG-TERM EFFECTS OF X IRRADIATION IN PATIENTS TREATED FOR METROPATHIA HAEMORRHAGICA. Doll, Richard (University Coll. Hospital Medical School, London); Smith, P. G. Brit. J. Radiol., 41: 362-8(May 1968).

Long-term effects of irradiating a small part of the body with x rays were observed in 2068 patients whose ovaries were irradiated to produce an artificial menopause. Ninety-seven per cent of the patients were treated for metropathia haemorrhagica and the remainder for other benign gynaecological disorders. The patients were treated at three Scottish radiotherapy centers be-

tween 1940 and 1960 and were followed to January 1, 1964. Fourteen (0.7 per cent) could not be traced and 245 (11.8 per cent) had died. The numbers of deaths from different causes were compared with the numbers expected in a similar population exposed to the Scottish national mortality rates over the same period. Five or more years after treatment, the observed mortality was greater than expected for leukemia (six deaths against 1.0) and for cancers of other directly irradiated sites (31 deaths against 18.4); it was less than expected for cancer of the breast (five deaths against 10.5) and close to that expected for other cancers, coronary thrombosis and other causes. The average mean marrow dose was estimated at 136 rads. Previous observations on subjects who received more widespread irradiation suggest that this dose would produce about six cases of leukemia in 10 to 20 years. The results are, therefore, consistent with the hypothesis that the risk of leukemia induction if proportional to the total energy absorbed in the marrow irrespective of the volume irradiated. (auth)

40836 "ANOXIC" RADIATION RESPONSE IN CULTURED MAMMALIAN CELLS. Belli, James A.; Roach, Alice (Univ. of Texas, Dallas). Brit. J. Radiol., 41: 390-1(May 1968).

A known number of single Chinese hamster cells were plated on Petri dishes and colonies were allowed to develop. Anoxic conditions were produced by the use of nitrogen. Following x irradiation, the cells were overlayed with fresh medium and incubated in a humidified CO_2 atmosphere. Graphs are presented to show the relation between survival in air and nitrogen and various pre-exposure gassing times. It was concluded that the time necessary to remove oxygen to levels that produce significant changes in radiation response is very short, requiring seconds rather than hours. (H.L.W.)

40837 BONE MARROW CELLS REGENERATION UNDER THE EFFECT OF POSTRADIATION BLEEDING IN IRRADIATED RATS. Ninkov, Vukosava; Hajdukovic, Srdjan (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 134: 53-7(Sept. 1967).

Effect of immediate postradiation bleeding on recovery yield of bone marrow cells in rats after exposure to 800 R was studied. Bleeding amounting to 45% of total blood volume decreased the time interval needed for the onset of recovery (48 hours as compared to the controls) and intensified markedly bone marrow cells proliferation. (auth)

40838 PROBLEMS CONCERNING THE USE OF COMBINED RADIOTHERAPY AND IONIZING RADIATION. ANIMAL EXPERIMENTS WITH NATULAN AND CONVENTIONAL RADIOTHERAPY. Schneider, Rudolf (Univ., Marburg, Ger.). Strahlentherapie, 134: 21-30(Sept. 1967). (In German).

Simultaneous treatment with a cytostatic substance (Natulan) and ionizing radiation had an additive effect upon some organs and upon the inoculation tumor in Albino rats and mice. This combination did not show an additive effect, however, when the dose of the chemotherapeutic substance or the radiation was high. (auth)

40839 TEMPORAL DISTRIBUTION OF DEATH OF MICE FOLLOWING A SINGLE WHOLE-BODY X IRRADIATION WITH DOSES BETWEEN 15 kR AND 180 kR. Frankenberg, Dieter (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Strahlentherapie, 134: 80-91(Sept. 1967). (In German).

Groups of 40 to 295 mice were exposed to 19 different x-ray doses ranging from 15 kR to 180 kR. The number of mice in these groups depended on the pattern of the temporal distribution of death. Altogether, 2070 mice were irradiated. Irradiations were performed with an x-ray machine that was constructed especially for the purpose of irradiation at high dose rates under the following conditions: 70 kV_p, 1000 mA, HVL 12 mm H_2O, Focus distance (focus to midline of the mouse) 6 cm, dose-rate 230 kR/min. From experimental results one could separate at least five different statistical universes G_i (i = 1 ... 5) for doses higher than 15 kR. As these statistical universes were composed of mice with distinct survival times each statistical universe could be regarded as the consequence of a definite mechanism M_i (i = 1 ... 5). The dose-dependent fractions of the five mechanisms in the total lethality were calculated because of the experimental results. These fractions were regarded as the probabilities of the mechanisms M_i to kill an irradiated animal. Bearing in mind the pattern of the temporal distribution of death and their dose-dependent conformities a mathematical description of the dose response curve for doses higher than 15 kR was made. The calculated survival times was in good agreement with the experimental values. The applicability of this mathematical model to the whole dose response curve from 450 R to 180 R was discussed. (auth)

40840 STUDIES ON MITOTIC CHANGES IN MOUSE BONE MARROW AFTER A SINGLE WHOLE-BODY X RADIATION. Zak, Miroslav (Charles Univ., Prague). Strahlentherapie, 134: 58-65(Sept. 1967). (In German).

Changes of mitotic activity at various mitotic phases were observed in bone marrow of mice after a single whole-body irradiation with x rays. The values were determined one, five, 14, and 28 days after irradiation with 100, 600, and 1000 R. A dose of 100 R resulted in a varying course of mitotic activity with a low one day after irradiation. After the time intervals, the mitotic activity was not significantly increased in comparison to the non-irradiated mice. More cells were in mitosis, but the number of the later mitotic phases was higher than the number of the initial mitotic phases. A radiation dose of 600 R clearly decreased the mitotic activity; 20% less cells were in mitosis than in the non-irradiated animals. The number of later mitotic phases was significantly higher than the number of initial mitotic phases. Irradiation with 1000 R caused an irreparable bone marrow inhibition. A smaller number of cells started mitosis and the number of later mitotic phases was clearly higher than the number of initial phases. Irradiation inhibited proliferation and slowed down the mitotic cycle of later mitotic phases. This method could be used to solve the problem of immature elements in peripheral blood after irradiation. (auth)

40841 CELL PROLIFERATION IN THE REGENERATING LIVER OF CONTINUOUSLY IRRADIATED MICE; EFFECT OF A RADIATION-FREE INTERVAL. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore). Brit. J. Radiol., 41: 369-74(May 1968).

The effect on liver regeneration of a ten-day, radiation-free interval between the end of continuous exposure at 47 rads per day for 15 days and partial hepatectomy was examined in C57BL mice. Changes in body weight, liver weight, tritiated thymidine labeling indices in proliferating parenchymal and littoral cell populations, and parenchymal cell nuclear grain counts were determined at frequent intervals during the first two weeks after partial hepatectomy. In mice γ-irradiated up to the time of hepatectomy, there was a lag in the rate of growth in the hepatic remnant and a decrease in the proportion of cells proliferating during the regenerative process. A radiation-free interval prior to partial hepatectomy improved the regenerative capacity by decreasing the extent of radiation inhibition of parenchymal cell proliferation primarily during the second and third days. As far as the proliferative pattern of the regenerating liver was concerned, it appeared that under continuous irradiation, the most recent exposure was the most effective, and recovery from sublethal cellular damage and improved regenerative capacity can occur in tissues, such as the liver, with normally low rates of cell proliferation. (auth)

40842 EFFECT OF THE MOMENT OF IRRADIATION WITH X RAYS ON THE REGENERATION AND THE RATE OF INCORPORATION OF TRITIATED URIDINE IN THE PLANARIA DUGESIA GENOCEPHALA (TURBELLARIE, TRICLADE). Gabriel, Andre (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. D, 266: 820-2(Feb. 19, 1968). (In French).

When Planaria were x irradiated before amputation, regeneration was inhibited. When irradiation was delayed 6 hrs, regeneration was observed. In individuals normal in regeneration, an increased incorporation of ^{3}H-uridine was observed which indicated that the new growth cells were activated. If the irradiation was before the amputation, the augmentation of the incorporation was not produced. (tr-auth)

40843 MODIFICATIONS OF THE VIGILANCE IN THE ADULT RABBIT EXPOSED TO NONLETHAL WHOLE-BODY γ IRRADIATION. Court, Louis; Magnien, Patrick; Avargues, Marcel; Laget, Paul (Centre de Recherches du Service de Sante des Armees, Paris. CEA, Fontenay-aux-Roses, France. Faculte des Sciences, Paris). Compt. Rend., Ser. D, 266: 1052-5(Mar. 4, 1968). (In French).

Rabbits exposed to non-lethal whole-body γ irradiation at 400 rads, showed modifications in vigilance. This confirmed results of studies on the effects of radiation on spontaneous cortical activity. (tr-auth)

40844 EFFECTS OF 14.1 MeV NEUTRON IRRADIATION ON THE HEMATOPOIETIC ORGANS OF RATS. Hirose, Fumio; Wake, Minoru (Hiroshima Univ.). J. Radiat. Res., 7: 146-66 (Sept.-Dec. 1966).

For the purpose of observing the effects of fast neutron irradiation on the hematopoietic organs of rats. Wistar rats were administered a single exposure of 500 rads and 400 rads of 14.1 MeV neutron irradiation and repeated exposures of 200 rads of neutron irradiation. These results were compared to those given by the same absorbed dose of 180 kVP x-ray and ^{60}Co gamma ray irradiation. The effects of fast neutron irradiation on the hematopoietic organs of rats showed no remarkable difference from

those in mice, but they were stronger than those following x-ray irradiation and gamma ray irradiation. The bone marrow of rats exposed to neutron irradiation showed a picture of characteristic damage and regeneration as in the case of mice. Though a remarkable damage to the bone marrow was observed in animals given repeated neutron irradiations, there was no animal which experienced acute death. This is considered to be owing to the absence of ulceration in the intestinal mucosa. The RBE of 14.1 MeV neutron for the 50% decrease in thymus weight of rats was approximately 1.2 against 180 kVP x-ray and approximately 1.4 against ^{60}Co gamma ray irradiation. (auth)

40845 THE "POINT-SOURCE" IRRADIATED CANINE KIDNEY: ANGIOGRAPHIC AND PATHOLOGIC EVALUATION. Vinik, M.; Nakoneczna, I.; Neal, M. P.; Freed, T. A. (Medical Coll. of Virginia, Richmond). Radiology, 91: 123-31(July 1968).

Angiographic, microangiographic, and pathologic findings in the sequential vascular response to irradiation of kidneys in dogs following the implantation of grains of ^{198}Au are described. The orderly vascular supply of the kidney was suited for such evaluation; the use of point-source irradiation enhanced the validity of the observations. The pattern of irradiation injury was largely related to the depth of the source within the kidney and the proximity of larger intrarenal arteries to the zone of intense irradiation. (auth)

40846 INFLUENCE OF X IRRADIATION ON THE SURVIVAL TO TRAUMA. Reichard, Sherwood M. (Medical Coll. of Georgia, Augusta). Radiology, 91: 132-9(July 1968).

An increased lethality of biological shock induced by drum trauma was produced in rats by previous exposure to sublethal amounts of total-body x radiation. No changes in survival were seen when the rats were exposed to trauma four hours after irradiation, but by two days, a significantly lowered survival rate was apparent; a maximal synergistic effect was obtained at ten days. Shielding the midsection or the exteriorized spleen prevented this increased susceptibility. Impairment of the RES caused a similar increase in susceptibility to biological shock induced by drum trauma. Stimulation of the phagocytic activity of the RES with injections of zymosan, a cell wall preparation of yeast, repeated injections of bacterial endotoxins, choline, or denatured human serum albumin aggregate overcame the potentiating effect of irradiation. However, survival was decreased in animals in which stimulation of the RES was prevented by blockade procedures. Exposure to x radiation did not alter the adaptation to drum trauma produced in conditioned animals. The increased susceptibility to traumatic shock may be caused by an altered function of the reticuloendothelial system brought about by the ionizing radiation. (auth)

40847 RADIATION EFFECTS ON DEVELOPMENT OF NEOPLASMS IN OVARIES. Gubareva, A. V. Med. Radiol., 13: No. 2, 86(Feb. 1968). (In Russian).

Neoplastic effects of radiation on ovaries of mice were studied. Experiments were conducted with 994 virgin white mice that were exposed to single whole-body γ radiation doses of 200 R or 900 R. The structural changes in ovaries of mice exposed to 200 and 900 R were identical. The mean size of tumors in mice exposed to 900 R was less than in mice exposed to 200 R. The frequency of tumor formation 12 to 18 months postirradiation was 60.9% for the 200 R dose and 65.5% for the 900 R dose.(R.V.J.)

40848 MORPHOLOGICAL CHANGES FOLLOWING IRRADIATION OF A SEGMENT OF THE RAT THYMUS. Engeset, Arnfinn; Schooley, John C. (Univ. of California, Berkeley). Proc. Soc. Exp. Biol. Med., 128: 26-31(May 1968).

A method is described for producing a narrow region of irradiation damage in the rat thymus bounded by normal thymic tissue. The mitotic and pyknotic indices of the shielded area of the thymus are comparable to those in normal thymic tissue indicating that the shielding is effective. The pattern of repopulation of the irradiated thymus is described. The source of the cells responsible for the repopulation is unknown; however, it is evident that an extensive migration of small thymocytes from the unirradiated area of the thymus into the irradiated area does not occur. (auth)

40849 ELECTROCARDIOGRAPHIC STUDIES DURING ^{60}Co TELETHERAPY OF THE CARDIAC REGION. Kleinert, Hellmut; Kuttig, Helmut; Wieland, Cuno (Univ., Heidelberg). Strahlentherapie, 134: 339-49(Nov. 1967). (In German).

An electrocardiogram was done on 53 patients before, during and at the end of a telecobalttherapy. It was shown that normal hearts were not influenced by radiation up to therapeutic doses. When some pathology was present before the treatment, no further modification was detected. If further aggravation was seen, it was ascribed to radiation pneumonitis, pulmonary fibrosis, or scar formation. A direct influence on the sympathetic or the nervous system was most probable. (auth)

40850 RESPONSE OF BONE MARROW CELLS AFTER WHOLE-BODY IRRADIATION AND PARTIAL PROTECTION IN RATS. Ninkov, Vukosava (Boris Kidric Inst. of Nuclear Science, Belgrade). Strahlentherapie, 134: 463-8(Nov. 1967).

Changes in proliferative activity of bone marrow cells were studied. The hematological response given by the shielded bone marrow and irradiated bone marrow after spontaneous hematopoiesis following 600 R and 800 R was noted. The results showed that in rats exposed to 600 R regenerative processes started in irradiated bone marrow on the 6th day and in rats exposed to 800 R on the 7th day following irradiation. In the shielded bone marrow proliferative activity of erythroid cells was completely depressed after 800 R, while at a dose of 600 R it was diminished for about 50% from the third to 10th day of observation. At the same time in the shielded bone marrow very intensive myelopoesis occurred that was 80 to 141% above normal values. (auth)

40851 COMPARATIVE RESPONSE OF NORMAL REGENERATIVE AND TUMOUR TISSUE OF RATS TO ELECTRONS AND PHOTONS MEASURED BY THE MITOTIC ACTIVITY. Rytilae, A.; Voutilainen, A. (Univ. of Helsinki). Radiol. Clin. Biol., 37: 13-18(1968).

The comparative response to radiation was expressed as a ratio of the effects of equal doses of radiation. The regeneration of the liver of rats was produced by performing 70 per cent hepatectomy. After two days the rest of the liver was irradiated. The Walker tumor was implanted under the skin of the interscapular region and the irradiation was given after ten days. The irradiation consisted of cobalt-60 γ-rays, 200 kVp x rays, 32 MeV photons, and both 20 and 35 MeV electrons. The absorbed dose was 300 rads given at a rate of 40 rad/min. The animals were decapitated 12 hr after irradiation. The average comparative response to high energy radiation as a ratio of the mean mitotic loss was on the whole smaller in the tumor groups than in the normal tissue groups. (auth)

40852 NEOPLASTIC SKIN RESPONSE OF RATS AFTER 13 MeV PROTON IRRADIATION. Casey, Harold W.; Prince, John E.; Hinkle, Donald K.; Caraway, Bobby L.; Williams, William T. (School of Aerospace Medicine, Brooks AFB, Tex.). Aerosp. Med., 39: 360-5(Apr. 1968).

The incidence of skin neoplasms in rats that received 13 MeV proton whole-body radiation is reported. Three groups of rats were irradiated with a single dose from 100 to 2500 rads and were observed for 8, 21, and 30 months post-irradiation. A total of 121 neoplasms were diagnosed in 79 irradiated rats and a skin tumor was diagnosed in one of 13 control rats. Of the 121 neoplasms that occurred in the irradiated rats, 117 developed in the skin and a high percentage of these tumors was considered radiation induced. The incidence of neoplasia could not be related to the magnitude of the radiation dose as doses as low as 200 rads produced a high tumor incidence. Both epithelial and mesenchymal tumors were detected. Squamous cell carcinomas, basal cell tumors, fibrosarcomas and fibromas were the most common neoplasms diagnosed. (auth)

40853 INFLUENCE OF LETHAL X IRRADIATION ON TRACE METAL UPTAKE BY THE MITOCHONDRION. Decker, W. J. (General Hospital, El Paso, Tex.). Experientia, 24: 448-9 (May 15, 1968).

Rats were exposed to a dose of 900 rads whole-body x radiation and one, three, or six days later they were sacrificed and the spleens were removed immediately and processed to isolate mitochondria. The mitochondrial pellets were placed in sucrose-KCl-buffer solution, trace amounts of ^{58}Co, ^{51}Cr, ^{59}Fe, ^{54}Mn, ^{75}Se, or ^{65}Zn were added to separate samples, the samples were incubated for one hour at 4°C, and the uptake of each metal by mitochondria was measured over a six-day period. The pattern of change in cation uptake appeared to be somewhat complex. Increased uptakes of Co, Fe, Ni, Se, and Zn and decreased uptakes of Cr and Mn were noted in mitochondria from irradiated animals compared with those from controls. A marked increase in Fe content and a decreased uptake of Fe were noted, and both content and uptake of Zn almost doubled during the first and second days following irradiation but decreased to values lower than those of controls by the sixth day. (C.H.)

40854 THE RELATIVE BIOLOGIC EFFECTIVENESS OF ^{60}Co GAMMA AND 200 kV. X RADIATION FOR CATARACT INDUCTION. Focht, Elizabeth F. (New York Hospital–Cornell Medical Center, New York); Merriam, George R.; Schwartz, Melvin S.; Parsons, R. Wayne. Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 71-80(Jan. 1968).

The relative biologic effectiveness (RBE) of ^{60}Co radiation of 200 kVp x radiation at a half value layer of 1.0 mm. copper was determined for the induction of cataracts in rats. Groups of 25 to 30 animals were used for each quality and quantity of radiation. Single and divided doses of 1,500 rads of γ radiation were com-

pared with the same dose and treatment time for x radiation. The animals were examined before exposure and every few weeks thereafter. Statistical analysis of the results showed no significant difference between the two energies of radiation. Therefore, in this study the RBE was unity for ^{60}Co γ radiation compared to 200 kVp x radiation for the induction of cataracts in the rat lens at a dose of 1,500 rads with single or divided treatments as described. (auth)

40855 CHROMOSOMAL ABERRATIONS FOLLOWING OCULAR IRRADIATION. Hung, Por Tying (National Taiwan Univ., Taipei). Amer. J. Ophthalmol., 65: 866-72(June 1968).

Chromosomal studies of peripheral blood cultures were made after radiotherapy in three patients with ocular malignancy, and in one patient after diagnostic skull x rays. Comparable blood cultures from four nonirradiated control subjects were studied with each experimental specimen on a blind-study basis. Significant chromosomal aberrations of peripheral blood cells were detectable in patients who underwent irradiation therapy for ocular disease. These were found as early as 24 hours after local exposure of 357 R in a 4-year-old boy, and persisted 65 days after local exposure of 8,550 R in a 47-year-old man. A patient who had undergone diagnostic skull x rays at 21.6 R also manifested chromosomal damage. Rings, dicentrics, and fragments were the most important findings. The degree of deviation of chromosome count from 46 was also significant in irradiated patients. (auth)

40856 INFLUENCE OF HOST PROTEIN NUTRITION ON THE RESPONSE OF VARIOUS TUMORS TO IONIZING RADIATION. Yatvin, Milton B.; Hinke, Dayton H. (Univ. of Wisconsin, Madison). Proc. Soc. Exp. Biol. Med., 128: 200-6(May 1968).

The response of various transplantable tumors to a fractionated course of radiation therapy was studied in host mice and rats fed different levels of dietary protein. The parameters employed in evaluating the effect of diet were: tumor growth, tumor cure, and host survival time. The tumor used in these studies most genetically divergent from its host (Sarcoma 180) showed the most striking response to diet and radiation. Tumors less divergent from their hosts were markedly less responsive. It is proposed that the varying responses obtained in these studies can be explained on the basis of the protein reserves of the host, and the genetic composition of the tumor with respect to its host and the resulting immunological consequences. (auth)

40857 ELECTROCARDIOGRAPHIC STUDY OF CARDIAC DAMAGE SECONDARY TO RADIOTHERAPY OF MALIGNANT INTRATHORACIC TUMORS. Takaoka, A.; Kaneda, H.; Urano, M.; Kikkawa, S. (Kyoto Prefectural Univ. of Medicine). Radiol. Clin. Biol., 37: 1-12(1968).

The electrocardiograms of 41 patients with intrathoracic tumors who were treated by telecobalt-60 sieve therapy, and who received more than 4000 R in at least 30 cm^2 of their cardiac area were studied. Special attention was given to the corrected Q-T interval (Q-Tc interval). In 37 out of 41 patients, a prolongation of the Q-Tc interval was observed (91%). In time, the length of Q-Tc interval showed a bimodal curve. The mean Q-Tc interval of 41 patients exceeded normal limits during the radiotherapy, reached a maximum at the last day of treatment, and returned to normal within a month after therapy (early effect). This prolongation of Q-Tc interval again appeared approximately 12 months after the termination of treatment (late effect). The early effect is probably caused by radioinduced myocardial damage. The prolongation of Q-Tc interval at this time is proportional to the cardiac dose and irradiated cardiac area. It is impossible to state whether late effect is attributable to radiation or to poor general condition of these patients with a poor prognosis. (auth)

40858 HEPATIC EFFECTS FOLLOWING ABDOMINAL IRRADIATION IN CHILDREN: DETECTION BY ^{198}Au SCAN AND CONFIRMATION BY HISTOLOGIC EXAMINATION. Fellows, K. E. Jr.; Vawter, G. F.; Tefft, M. (Children's Hospital Medical Center, Boston. Harvard Medical School, Boston). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 103: 422-31(June 1968).

Cases of five patients of pediatric age group are reported; defects in liver scans appeared and persisted following abdominal irradiation for malignant disease. At least a part of the liver in each case was included in the treatment fields. The single dose equivalent in each case was in the range of 1,400 R, and the 6 week equivalent dose, 4,250 R of x radiation. In all cases, a sample of the area of liver affected was examined histologically and demonstrated the primary lesion to be hepatic venous obstruction at the sublobular level. The liver scans made using ^{131}I rose bengal or ^{198}Au colloid, and the histopathologic changes reported are further evidence that the liver is a more radiosensitive organ than previously believed. (auth)

40859 ULTRASTRUCTURAL STUDIES OF X-RAY-INDUCED GLOMERULAR DISEASE IN RATS SUBJECTED TO UNINEPHRECTOMY AND FOOD RESTRICTION. Rosen, Victor J. (Veterans Administration Center, Los Angeles); Cole, Leonard J.; Wachtel, L. W.; Doggett, R. S. Lab. Invest., 18: 260-8(Mar. 1968).

The effect of undernutrition on the ultrastructure of accelerated irradiation-induced glomerulosclerosis was studied in weanling female Sprague-Dawley rats. Following uninephrectomy and 2000-rad x irradiation of the remaining kidney, a severe, destructive glomerular alteration appeared within seven to eight weeks. Food restriction resulting in significant growth retardation caused marked inhibition of the glomerular lesions. Ultrastructurally there was marked reduction in all cytoplasmic organelles and a striking reduction in mesangial matrix deposition. Luminal obliteration by swollen and proliferated endothelium did not occur. Thus, food restriction retards the development or manifestation of direct radiation effects on the kidney, and confirms the concept that a stimulus for growth, combined with the direct effects of radiation, accelerates the development of glomerulosclerosis, while growth retardation has a profound inhibiting effect on the evolution of the lesion. There is evidence that immunoglobulins are present in the mesangial matrix after irradiation; underfeeding may reduce the synthesis of these globulins. (BBB)

40860 THE MODIFICATION OF ADULT LIFE SPAN IN BRACON HEBETOR (HYMENOPTERA: BRACONIDAE) BY IRRADIATION IN NITROGEN. Clark, Arnold M.; Smith, Robert E. (Univ. of Delaware, Newark). Ann. Entomol. Soc. Amer., 61: 541-2(Mar. 1968).

Adult lifespan was used as the measure of radiation damage in the parasitic wasp B. hebetor, adults of which can be kept under anoxic conditions for at least 30 min without apparent injury. Newly emerged adult females were exposed to 50,000 or 100,000 R of x rays at a rate of 3000 R/min. Some were exposed in the presence of 100% nitrogen and others in air. In one experiment, γ rays from a ^{60}Co were used at a rate of 3000 R/min. All insects were immobilized by exposure to nitrogen but recovered within 10 min when returned to air. The results indicated that the adult life was decreased less after exposure to ionizing radiation in the presence of nitrogen than in the presence of air. Thus, adult lifespan can be modified by irradiation in the absence of oxygen. This fact indicates another variable that can be used in studies dealing with radiation damage and adult lifespan. (BBB)

40861 RADIOSENSITIVITY OF THE SUBEPENDYMAL CELL LAYER OF THE ADULT RAT BRAIN. Lewis, P. D. (Inst. of Neurology, London). Exp. Neurol., 20: 208-14(Feb. 1968).

The possibility that thymidine-^{3}H injected into the brain may have a radiation effect on brain cells was investigated. Adult rats of the WAG/C strain, weighing between 150 and 240 g, were given a single intracerebral injection of 10 or 50 μCi of thymidine-^{3}H and labeling of the subependymal layer was studied by autoradiography. Labeling was symmetrical in the subependymal zones of the left and right lateral ventricles of rats killed after 5 min. This brief autoradiographic exposure time was sufficient to produce a mean grain count of 16.5 per nucleus at 8 hr and 15.0 per nucleus at 26 hr survival after injection. The percentage of labeled mitoses (metaphases and anaphases) in the subependymal layer of the lateral ventricles was a function of time after injection of tritiated thymidine. After 1 hr, 20% of mitoses were labeled. There was a linear increase to 80% at 4 hr and thereafter about 90% of mitotic figures were labeled, this being maintained until at least 26 hr. A few pyknotic nuclei were observed soon after labeling in the subependymal layer, and after 5 hr many abnormal nuclei were seen. There was a peak at 8 hr, a fall to about half this level at 12 hr, and a gradual rise up to 30 hr. Other abnormalities included vacuolation of nuclei. Thus, a disturbance of cell proliferation was observed, and this and histological changes in the layer could be attributed to the effects of endogenous irradiation of nuclei from newly formed radioactive DNA. The limited usefulness of intracerebral injection of tritiated thymidine is discussed. (BBB)

40862 RADIATION PNEUMONITIS IN SINGLE AND PARABIOTIC RATS. I. SHORT-TERM EFFECTS OF SUPRALETHAL TOTAL-BODY IRRADIATION. Goldenberg, Victor E. (Univ. of Washington, Seattle); Warren, Shields; Chute, Rosanna; Besen, Martin. Lab. Invest., 18: 215-26(Mar. 1968).

Lung tissue of single and parabiotic pairs of rats was studied by light and electron microscopy one and two weeks after 1000-R x irradiation. Only one rat of a parabiotic pair was irradiated. The ultrastructural changes consisted of abundant intraalveolar osmiophilic inclusion-type material and increasingly severe cytoplasmic damage and sloughing of large alveolar epithelial cells (granular pneumocytes). There was also evidence of marked septal edema, mesenchymal septal cell proliferation, and increased septal collagen and elastin. These changes were observed in both single irradiated rats and irradiated partners of parabiotic pairs but were much more severe in the former.

Hyaline membranes, collapse and fusion of alveolar septa, and mineral deposition in the septa were observed in single animals but were conspicuously absent in irradiated parabionts. It was concluded that parabiosis can prevent, to a considerable extent, the massive alveolar damage caused by supralethal total-body irradiation. Shielded partners of irradiated pairs and control nonirradiated parabionts showed mild septal edema and slight septal fibrosis. These unexplained changes might be attributed to immunologic reactions. (BBB)

40863 USES OF IONIZING RADIATION IN EXPERIMENTAL NEUROPATHOLOGY. **Miquel, J.; Haymaker, W. (Moffet Field, Ames Research Center, Calif.). Scientia (Milan), 102: 549-53 (Nov. 12, 1967).**

Brain edema can be produced with great uniformity by exposing the brain of rats or cats to irradiation with 41.6-MeV α particles and 31-MeV protons. A superficial band of necrosis was produced in the irradiated cortex, with edema spreading in the underlying white matter. The cortical zone of necrosis was shallow. The irradiation could be performed through the intact skull, affording the possibility of studying the edematous process in conditions similar to those occurring in non-craniotomized patients. The irradiation-induced edema may be considered similar to that produced clinically by infarctions, abscesses, tumors, and surgical interventions. In clinical and radiation-induced edema the histological changes are practically identical, both being characterized by exudation of fluid with separation of the neuroglial meshwork and progressive astroglial reactions. Radiation-induced edema is, therefore, a useful model for morphological, histochemical, and biochemical observations. This model may also prove suitable for studies dealing with the therapy of brain edema. (BBB)

40864 HYPOGONADISM AFTER MICROWAVE RADIATION. Rosenthal, David S.; Beering, Steven C. (Wilford Hall USAF Hospital, Lackland Air Force Base, Tex.). J. Amer. Med. Ass., 205: 245-8(July 22, 1968).

A 31-year-old man was repeatedly exposed at close range to high-powered microwave emission over a four-year period. Testicular biopsy revealed tubular atrophy with focal necrosis and interstitial edema. Hypospermia continued for a period of at least a year after the patient's last exposure. (auth)

40865 RADIATION-INDUCED CANCERS (A PROPOS OF 2 CASES). **Piquet, J. J.; Dessaulty, A.; Decroix, G. (Centre Hospitalier Regional, Lille). Ann. Oto-Laryngol., 84: 125-9(Jan.-Feb. 1967). (In French).**

Two cases of radioinduced cancer in the neck and throat area are reported. The first case was that of thyroid cancer in a 62-year-old woman with extreme dysphagia; at age 45 she underwent x ray therapy for Basedow's disease (goiter). The doses were given at 200 KV over two fields and were 3000 R, followed by 4000 R five months later, and 4000 R six months after that; total dose was 11,000 R in each field. After 17 years, the latent radioinduced cancer appeared in the zone of irradiation and produced cutaneous lesions and edema of the pharyngeal mucous membrane. A complete pharyngolaryngectomy including part of the thyroid gland was successfully performed. The other case was of a rarer tumor that involved the endolarynx. A 42-year-old man with cancer of the larynx was subjected to Ra treatment for papillomas of the larynx after a tracheotomy at age 3. The doses were ~4000 R and after 1 yr the total dose went up to 6000 R per mo. Surgical treatment was also used. Caution was urged in the use of radiation treatment of papillomas in children since they sometimes degenerate spontaneously. (BBB)

40866 EFFECTS OF LASERS ON THE HUMAN EYE. **Makous, W. L. (Univ. of Washington, Seattle); Gould, J. D. IBM J. Res. Develop., 12: 257-71(May 1968).**

Theoretical aspects of laser injury to the human eye are considered. A new approach to understanding laser radiation damage to the eye is developed by means of a model limited to conditions existing only at the threshold of damage. It is shown that such threshold damage to the visual system is primarily caused by the effects of heat alone, but that photochemical effects and acoustic shockwaves can potentially be a cause of the threshold damage that cannot be entirely rejected under all conditions. A theoretical estimate of retinal irradiance for threshold damage is made and shown to be consistent with empirical findings. A survey of empirically determined damage thresholds is presented. A valid method of computing retinal irradiance from a laser is given, and the direction and magnitude of errors in earlier formulations are pointed out. (BBB)

40867 EFFECT OF RADIOACTIVE TAGS ON THE ACTIVITY OF RODENTS. **Barbour, Roger W.; Harvey, Michael J. (Univ. of Kentucky, Lexington). Amer. Midland Natur., 79: 519-22(Apr. 1968).**

A comparative study of the activity of ^{60}Co-tagged vs normal Microtus ochrogaster and Baiomys taylori was conducted in the lab. After a preliminary observation period, a 0.7 × 2.5 mm 45-mCi ^{60}Co alloy wire was subcutaneously implanted in one animal of each pair; a hypodermic needle and plunger arrangement was used. The animals were then placed under cameras for a 48-hour post-tag observation period. Activity of each pair was compared for 48 hr prior to tagging one of them, for 48 hr immediately after tagging, and at subsequent intervals of 4 and 8 weeks after tagging. Gross weights of the animals were recorded before and after each 48-hr experimental period; food and water consumption of each was recorded. There were clear-cut differences in activity between the various pairs of animals tested, but they existed prior to tagging. There were no significant differences in the activity of the tagged and untagged animals. It was concluded that data derived from ^{60}Co tag-carrying mice of these species were valid, and that the activity of tagged animals was comparable to that of nontagged mice. (BBB)

40868 RADIOSENSITIVE INSECT. MEDIAN LETHAL DOSE FOR WHOLE-BODY IRRADIATION WITH ^{60}Co GAMMA RAYS OF LOCUSTA MIGRATORIA MIGRATORIOIDES R. ET F. **Austin, Shirley A. (Univ. of Witwatersrand, Johannesburg). Brit. J. Radiol., 40: 711-12(Sept. 1967).**

The proportion of young adult locusts (Locusta migratoria migratorioides) surviving 30 days after various doses of ^{60}Co γ radiation was analyzed by probit method, with corrections for natural mortality. Results indicated a median lethal dose ($LD_{50(30)}$) of 1024 ± 13 (S.E.) rads, with a coefficient of variation of 30 percent. The unusual radiosensitivity of this species was possibly associated with a high cellular turnover rate in the intestinal epithelium, in which case the locust might well be a most valuable test organism for radiobiological studies. (C.H.)

40869 RESPONSES OF CULTURED CELLS, TUMOURS, AND NORMAL TISSUES TO RADIATIONS OF DIFFERENT LINEAR ENERGY TRANSFER. **Barendsen, G. W. (Health Research Organization TNO, Rijswijk, Netherlands). pp 293-356 of Current Topics in Radiation Research. Vol. IV. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1968.**

When the same cell line is irradiated with different kinds of radiations the resulting survival curves differ. These differences as measured by in vitro cell-titration techniques, transplantable tumors, and normal tissues are reviewed. The implications of the data with respect to the kinds of radiation used for radiotherapy are considered. Distribution of dose in LET and mean LET, fundamental biophysical aspects of RBE-LET relations, a description of techniques, characteristics of survival curves obtained from radiations of different LET, RBE in relation to dose factors and cellular conditions, survival of rhabdomyosarcoma cells and tumor growth delay after irradiation with 15 MeV neutrons and 300 kV x rays, and factors affecting the relative sensitivities of tumors and normal tissues to fast neutrons and x rays in fractionated exposures are discussed. 117 references. (M.M.B.)

40870 INFLUENCE OF RADIATION ON HUMAN FERTILITY. **Mondorf, L.; Faber, M. (Finseninstitutet og Radiumstationen, Copenhagen). J. Reprod. Fert., 15: 165-9(Feb. 1968).**

Late effects of ionizing radiation on fertility were sought in a group of women who had been exposed to a large gonadal dose in childhood, during a disease of short duration which left no residual defect that later in life influenced fertility. An acceptable test population was found among children examined for intussusception by barium-enema under fluoroscopy control. The number of children born to 180 women (now ~50 yr old) exposed to abdominal fluoroscopy in connection with intussusception in infancy or childhood was compared to the number born to women who were treated for the same disease without fluoroscopy. No difference was found between the number of children born or the age distribution of birth between the two groups. The significance of this result in relation to the observed decrease in fertility in female mice irradiated with 20 R at varying ages shortly after birth is discussed. The sex ratio in this and a comparable series showed an unexpected though statistically nonsignificant increase in male births. It is generally accepted that gonadal irradiation of the mother will give rise to a shift in the sex ratio of the children with a preponderance of females. The 210 children of irradiated mothers showed an incidence of 0.443 female children while in the 208 children of nonirradiated mothers it was 0.522. (BBB)

40871 INDICATIONS FOR SUPERVOLTAGE RADIOTHERAPY. **Salzman, Ferdinand A.; Smedal, Magnus I. (Lahey Clinic Foundation, Boston). New Engl. J. Med., 277: 1295-6(Dec. 14, 1967).**

With the radiations from ^{60}Co or the Van de Graaff generator, the maximum deposition of energy occurs 3 to 4 mm beneath the skin surface. With orthovoltage radiation, maximum ioniza-

tion occurs nearer the skin surface, resulting in more marked skin reactions from equal doses of radiation. Most supervoltage technics, produce at most moderate skin erythemas instead of the more severe moist skin reactions that often accompany orthovoltage treatment. Even with the more severe skin reactions from orthovoltage, with deeper tumors, it is nearly impossible to deliver the high tumor doses possible with supervoltage radiation. With supervoltage radiation there are also fewer local tissue reactions, making palliation possible in sites where it would be hazardous to give other than supervoltage therapy. Because of their diminished tendency to scatter as they pass through matter, supervoltage radiations maintain a more sharply defined zone of ionization in depth than orthovoltage radiations. With supervoltage radiation differential bone absorption is much smaller. The severity of hematopoietic depression, nausea, and anorexia tends to increase proportionately with the integral dose. Supervoltage irradiation applied to deep tumors results in a clinically significant reduction of the integral dose for the same tumor dose delivered. Supervoltage radiotherapy is usually accomplished with greater comfort to the patient and proportionately less demand on his stamina and physiologic reserves. (BBB)

40872 THYROCALCITONIN DEFICIENCY AFTER TREATMENT OF THYROID DISORDERS BY SURGERY OR RADIOIODINE. **Smith, R. N.; Laljee, H. C. K. (Univ. of Sheffield, Eng. Royal Infirmary, Sheffield, Eng.). Brit. Med. J., 2: 589-91(Dec. 9, 1967).**

Studies included 24 patients who had been treated with ^{131}I for thyrotoxicosis from 2 to 15 yr previously and seven patients of similar age without any evidence of thyroid disorder. The response to Ca infusions after ^{131}I therapy differed significantly from preoperative and postoperative surgical groups and the control group. There was a positive correlation between the response to the Ca load and the time interval since the irradiation of the thyroid. No correlation was apparent in the ^{131}I group when the results were plotted in relation to the age of the patients or the total dose of Ca administered. Patients were all euthyroid, including those with post-^{131}I hypothyroidism who were on adequate replacement doses of thyroxine. It is probable that thyrocalcitonin production is deficient in some patients after ^{131}I therapy. Thyrocalcitonin deficiency can be demonstrated by challenging the thyroid with a Ca load before hypothyroidism is manifest. In patients treated with ^{131}I, thyrocalcitonin deficiency is time-dependent, but it may precede or follow the onset of hypothyroidism. (BBB)

40873 TETRACYCLINES FOR CONTROLLING OSTEORADIONECROSIS IN RAT MANDIBLES. **Alexander, Ricardo; Elzay, Richard P.; Dettman, Prentiss; King, E. Richard. J. Oral Surg., 25: 503-9(Nov. 1967).**

The molar regions of 44 rats, about five weeks old, were exposed to about 3000 R of x radiation and, two days later, the lower left first molars were extracted. Six nonirradiated rats were given tetracycline one day before extraction of their lower left first molars and served as controls. Of the 44 irradiated rats, 17 were given tetracycline the day before extraction and for 14 days afterward; the others were not given tetracycline. There was a 37% incidence of chronic osteoradionecrosis in the irradiated rats not given tetracycline. Of the 17 irradiated rats given tetracycline, only 18% had osteoradionecrosis, 65% of this group had complete bony repair of the sockets. It was suggested that administration of tetracycline to patients requiring extractions after irradiation of the jaws might reduce both the incidence of osteoradionecrosis of the mandible and the severity of the changes associated with development of osteoradionecrosis. (BBB)

40874 RELATIVE BIOLOGICAL EFFECTIVENESS OF TRITIUM BETA PARTICLES COMPARED TO GAMMA RADIATION: ITS DEPENDENCE ON DOSE-RATE. **Hall, E. J.; Oliver, R.; Bedford, J. S. (Churchill Hospital, Oxford). Brit. J. Radiol., 40: 704-10(Sept. 1967).**

The RBE of the β particles from ^{3}H in water relative to radium or ^{60}Co γ radiation was determined for HeLa cells cultured in vitro. For cell population growth rate under continuous irradiation at 0.5 to 3 rads/hour the RBE was about 2.0. For cell survival following exposures at 32 rads/hour the RBE was about 1.0. Using inhibition of root growth of Vicia seedlings as a test system RBE values of 1.6 and 1.0 were measured at dose rates of 1.52 and 46.3 rads/hour respectively. Such a dose-rate dependence of RBE is consistent with previously published results and the value of 1.7 used in the I.C.R.P. recommendations appears to be relevant to exposure at very low dose-rates. (auth)

40875 POSTNATAL RADIOSENSITIVITY FOLLOWING INTRAUTERINE RADIATION. **Vorisek, Premysl (Inst. for Mother and Child Care, Prague). Strahlentherapie, 134: 403-8(Nov. 1967). (In German).**

The influence of continuous intrauterine irradiation with a daily dose of 2.5 R (total dose 50 R) upon postnatal radiosensitivity was investigated. Additional gamma irradiation of 30 day old rats with 250, 300, 400, 450, and 500 R resulted in a LD 50/30 of 526 14 R in the preirradiated animals, and of 428.75 R in the control animals that had not received intrauterine irradiation. The relative effectiveness of the dose administered to preirradiated and non preirradiated animals was 113.6% with a certainty of 95% for the interval between 99.2 and 146.3%. The biological reaction was more favorable in animals that had received intrauterine irradiation. The difference in the effectiveness of the same doses was within 5%. (auth)

40876 CELLULAR EFFECTS OF IONIZING RADIATION. **Little, John B. (Harvard School of Public Health, Boston). New Engl. J. Med., 278: 308-15(Feb. 8, 1968).**

The effects of ionizing radiation related to the inhibition of cell division in mammalian cells were reviewed. Most of the evidence was taken from studies on cultured mammalian cells. Physical and chemical steps leading to the development of radiation injury of cells were outlined with a schematic representation of the development of ultimate physiologic damage. Specific differences were found among certain cell types, but a general pattern of cycle-related radiosensitivity emerged. Most cell lines appeared maximally sensitive during mitosis. The data fitted the mathematical expression for a multitarget single-hit model reasonably well. However, there was evidence of a constant change in both the number and size of the targets as cells progressed through the cycle, further evidence that a simple model did not pertain to mammalian cells. (TSS) (BBB)

40877 EFFECT OF HYPOXIA ON THE SKIN RESPONSE OF MICE TO DIVIDED DOSES OF 15 MeV ELECTRONS. **Berry, R. J. (Churchill Hospital, Oxford); Schwarz, G.; Ellis, R. E.; Lindop, Patricia J.; Fowler, J. F.; Hegazy, M. Int. J. Radiat. Biol., 12: 293-6(1967).**

One hundred and ninety-two SAS/4 male mice were given Nembutal anaesthesia and 45-sec nitrogen breathing. During the last 20-sec they were irradiated with 15 MeV electrons. Following the initial irradiation, the mice were revived by breathing pure oxygen for 1 min; 184 mice survived the initial severe hypoxia-irradiation period. A second dose of 15 MeV electrons was administered at intervals of 45 min to 24 hr following the first irradiation and skin responses were scored on 15 occasions from 9 to 30 days later. Results indicated that even as short an interval between doses as 45 min necessitated an increase in the second dose to produce a given level of skin response. This is interpreted as meaning that even severe hypoxia in vivo does not impair recovery phenomena which in this case is cyclic (peak and trough) in pattern. (E.R.B.)

40878 CURRENT TOPICS IN RADIATION RESEARCH. VOLUME III. **Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons, Inc., 1967. 233p.**

Separate abstracts were prepared on all five sections of the book. The technique of pulse radiolysis; the gulf separating radiochemistry from radiobiology; the immediate and transient responses to radiation in animal organs, nerve-muscle systems, and sensitive plants; the delayed effects of radiation in mammals; and the possibilities and advantages of using neutrons in tumor therapy are discussed. (B.H.S.)

For abstracts of individual sections see: 40125, 40126, 40780, 40878, 40880, and 40881.

40879 UNUSUAL FORM OF RESPONSE IN X-IRRADIATED PROTOZOA AND A HYPOTHESIS AS TO ITS ORIGIN. **Calkins, John (Univ. of Kentucky, Lexington). Int. J. Radiat. Biol., 12: 297-301(1967).**

Two experiments involving the effects of x radiation on survival of protozoa (Tetrahymena pyriformis and Paramecium aurelia) are cited and analyzed in an attempt to explain a proposed recovery system following irradiation of protozoa. The first system (N) repairs radiation damage and would result in the typical sigmoid survival curve seen following irradiation at low doses. The second system (T) is an activated system, inoperable after low doses, that is activated by radiation damage or some equivalent stimulus. The value of the second system must rest on its ability to repair a higher level of radiation damage than the (N) system. Although the system is defined on the basis of survival following x irradiation, it seems to explain other puzzling aspects of radiation response as well. (E.R.B.)

40880 IMMEDIATE, TRANSIENT RESPONSES TO IONIZING RADIATION. **Levy, Charles Kingsley (Boston Univ.). pp 95-137 of Current Topics in Radiation Research. Vol. III. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons Inc., 1967.**

An immediate radiation response is defined as those manifestations that appear within msec to min after exposure to ionizing radiation; a transient response is one having a duration of msec to several hr. Phenomena involving these kinds of responses are

radiation activation of sensory receptors, radioinduced behavioral and electrophysiological changes associated with release of biogenic amines, and biochemical changes and cellular changes. The data available from human, animal, and plant experiments on these responses are reviewed. A number of mechanisms appear to be involved. Direct activation was demonstrated in the case of some receptors, but the physicochemical mechanism is unknown. Other receptor responses may be due to the release of neurohumoral or humoral substances. There is increasing evidence that radiation may cause the release of bound transmitter substances with transient effects. Certain central olfactory bulb neurons may be activated by low radiation doses, but most cerebral and peripheral neurons are highly resistant to radiation. This is also true of the effector cells of smooth, cardiac, and skeletal muscles. 165 references. (M.M.B.)

40881 BIOLOGICAL MECHANISMS OF DELAYED RADIATION DAMAGE IN MAMMALS. Curtis, Howard J. (Brookhaven National Lab., Upton, N. Y.). pp 139-74 of Current Topics in Radiation Research. Vol. III. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons Inc., 1967. (BNL-10163).

In animals exposed to sublethal radiation doses the life expectancy is shortened by acceleration of the causes of death in old animals. In animals exposed to x and γ rays, there is a linear relation between life shortening and dose down to very small doses. For low energy neutrons, the dose-effect relation is also linear, but it extrapolates to zero. The dose-effect relation also holds for the individual causes of death, e.g., leukemia. For all types of radiations and radiation regimes so far tested, there is a quantitative relation between amount of life shortening produced by a given dose and chromosome aberrations induced. There is also a strain and species specific quantitative relation between aging and chromosome aberration rate in the absence of radiation. Animals appear to recover from much of the damage induced by x or γ irradiation, but not from that induced by neutron irradiation. Organs whose cells divide often may recover rapidly by cell selection, and contribute to aging by cancer development. Organs whose cells seldom if ever divide, recover from radiation damage slowly if at all, and contribute to aging by development of other degenerative diseases. 59 references. (M.M.B.)

40882 PRODUCTION OF LYMPHOCYTOPENIA BY SELECTIVE IRRADIATION IN DOGS: A COMPARISON OF TWO TECHNIQUES. Donahoo, James S.; Wilkinson, Charles P.; Weldon, Clarence S. (John Hopkins Univ., Baltimore, Md.). J. Surg. Res., 7: 475-80(Oct. 1967).

A simple technique was developed for selective irradiation that was effective in producing profound and sustained lymphocytopenia without harmful side effects. The technique was compared with results obtained by extracorporeal irradiation of whole blood. The described technique for irradiation of the subcutaneously implanted spleen of dogs for producing lymphocytopenia was superior to extracorporeal irradiation of the blood since marked and long-lasting reduction of absolute lymphocyte counts were obtained without the development of anemia and thrombocytopenia. The simplicity of the technique as compared to extracorporeal circulation was emphasized. Despite profound levels of lymphocytopenia in selectively irradiated host animals, allogenic renal grafts developed destructive changes and lymphoid infiltrates typical of the rejection reaction. (BBB)

40883 RELATION BETWEEN SURVIVAL PERIOD AND DOSE OF IRRADIATION IN RAT THYMOCYTES IN VITRO. Yamaguchi, Takeo (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol., 12: 235-42(1967).

The relations between dose, survival, and survival-time after exposure to x or γ rays of doses ranging from 20 to 200,000 R were examined with rat thymocytes in vitro. The shape of the curve of survival against survival-time suggested that the thymocyte population consisted mainly of two kinds of cells, differing in the time course of development of radiation damage. Over the dose-range 760 to 6,000 R, survival and survival-time were independent of dose. The causes leading to cell death were probably different below and above 6,000 R. (auth)

40884 EFFECT OF DOSE-RATE ON THE ACUTE LETHAL RESPONSE OF DOGS. Woodward, Kent T.; Michaelson, Solomon M.; Noonan, Thomas R.; Howland, Joe W. (Univ. of Rochester, N. Y.). Int. J. Radiat. Biol., 12: 265-76(1967).

The response of beagles exposed dorso-ventrally was determined for graded doses of 1000 kVp x rays administered at 1 and 11.4 or 12.2 R/min. The estimated median lethal dose for the higher intensity exposure was 386 RADs as compared with 524 RADs after exposure at 1 R/min. The time of onset of the acute radiation syndrome, incidence and severity of pathophysiological responses, and length of survival of beagles were dependent on total dose delivered and exposure intensity. For doses producing comparable mortality the onset of illness was accelerated and the signs more pronounced at the higher exposure intensity. Death ensued earlier after higher intensity irradiation. Studies in the literature for wholebody irradiation of dogs were summarized. An empirical relationship of median lethal dose to exposure intensity was derived. A two-fold change in effective dose for lethality production was noted over the intensities used, and at an exposure intensity of 1 R/min the estimated LD_{50} for the dog was 421 RADs. (auth)

40885 CHARACTERISTICS OF VASCULAR DYSTONIA IN SUBJECTS EXPOSED TO CHRONIC IRRADIATION. Zhmurkin, V. P.; Denisova, E. A.; Kirsanova, G. I.; Lvovskaya, E. N. (Central Inst. for Improvement of Physicians, Moscow). Ter. Arkh., 37: 46-50(Feb. 1965). (In Russian).

Studies are reported on 16 patients (aged 30 to 40 yr) chronically subjected to x-ray or γ-ray exposure. The clinical findings in these patients were compared with the results in 16 other patients who suffered from circulatory disorders of different (nonradiation) etiology. The most common and constant complaints of the irradiated patients were: general weakness, staggering gait, rapid fatigue, irascibility, sleep disturbances, chills, numbness of limbs, headaches (most frequent in occipital lobe and beginning in the evening or in the morning and that intensifed with coughing, exertion, and excitement), pressure sensation in eyes, general hyperesthesia, increased vascular tonus, and frequently subnormal temperature. The vascular tonus changes in irradiated patients resulted in hypertension especially in cerebral arteries and veins. Vascular tonus disorders were not examined in the abdominal cavity. (BBB)

40886 BREAKS IN NORMAL HUMAN CHROMOSOMES: ARE THEY INDUCED BY A TRANSFERABLE SUBSTANCE IN THE PLASMA OF PERSONS EXPOSED TO TOTAL-BODY IRRADIATION? Goh, Kong-oo; Sumner, Hatton (Oak Ridge Inst. of Nuclear Studies, Tenn.). Radiat. Res., 35: 171-81(1968).

A substance (or substances) produced or activated by wholebody irradiation in man and capable of affecting the chromosomes for an extended time was postulated previously. To test this hypothesis, experiments were carried out in which leukocytes from normal persons were cultured with autologous or homologous plasma and with plasma from irradiated patients. Five (1%) chromosomal breaks were found in the 461 metaphases from the control cultures, 6 (1%) in the 643 metaphases from the homologous cultures, and 114 (8.7%) in the 1318 metaphases from the experimental cultures. This finding indicates that the plasma from patients exposed to irradiation is capable of inducing chromosomal breakage in normal leukocytes. (auth)

40887 DISORDERS OF ELECTROLYTE METABOLISM IN INTESTINAL RADIATION SYNDROME. Bouckaert, A. (Univ. Louvain, Belgium). J. Belge Radiol., 51: 89-102(1968). (In French).

The main hypotheses concerning the cause of death in acute intestinal radiation disease are described and critically analyzed. The question of electrolyte metabolism disturbances, as it appears from both old and recent pertinent literature, is thoroughly reviewed. Various theories are discussed. (auth)

40888 ERYTHEMA FOLLOWING ADMINISTRATION OF IONIZING RADIATION. Van Caneghem, P. (Univ., Liege). J. Belge Radiol., 51: 84-88(1968). (In French).

It has been known for over 30 years that post-irradiation erythema can develop in waves. An attempt is made to explain this undulatory character in the light of some recent studies on the erythema and other reactions following irradiation: physio-pathological theory and theory based on the uneven distribution of the doses in the depth as developed by Bode, Markus, and Schlotfeldt. Special attention is given to the pathogenesis of the early erythema appearing within 24 hours after irradiation. (auth)

40889 INCREASED SURVIVAL OF IRRADIATED DOGS GIVEN TYPHOID VACCINE BEFORE OR AFTER IRRADIATION. Ainsworth, E. J.; Mitchell, F. A. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 34: 669-79(1968).

Previous studies showed that typhoid–paratyphoid vaccine (TAB) increased survival of irradiated dogs when given 24 hours before irradiation, but not when given one hour after irradiation. In extending the studies with dogs treated with TAB 24 hours before irradiation, we observed that lowering the TAB dose from 1.0 ml to 0.5 ml, with the intention of lowering toxicity to the animals, resulted in a smaller increase in survival. The LD_{50} of 457 R obtained for dogs given 1.0 ml of TAB 24 hours before x irradiation was approximately 140 R higher than for normal dogs. The pattern of postirradiation leukocyte counts in TAB-treated dogs was of particular interest. The most salient feature was a transient rise in the number of circulating granulocytes

which occurred during the second week after irradiation. Both the extent of the rise and the number of circulating granulocytes after the rise were radiation dose-dependent. Although the rise in granulocytes was quite impressive and could contribute to the animals' survival, the experiments with dogs treated 24 hours after irradiation showed that survival was increased even in the absence of a significant rise in granulocytes during the second week. These survival results are discussed in terms of TAB-induced changes in the bone marrow. (auth)

40890 INFLUENCE OF AGE AT EXPOSURE ON SOME PERSISTENT AND LATE EFFECTS OF IRRADIATION WITH FAST NEUTRONS. Jones, D. C.; Osborn, G. K.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 34: 637-47(1968).

In a duration-of-life study, male Sprague-Dawley rats were exposed to 220 rads of fast neutrons as juveniles (1 month of age), young adults (3 months), middle-aged adults (10, 15 months), or old adults (21 months) and compared with their sham-irradiated littermates at intervals using a variety of criteria of radiation injury. In all five age groups, there was a deficit in body weight that persisted throughout life. The magnitude of this deficit was inversely related to age at exposure. Decreased food and water consumption were seen throughout life in the group irradiated as juveniles and, to a lesser extent, after exposure as young or middle-aged adults. These consummatory changes appeared related to the changes in body size. An age-associated marked increase in water consumption per unit metabolic size occurred earlier (than in controls) in animals exposed as juveniles or as young adults. Proportions of exposed groups with one or more palpable tumors were in excess of control values after exposure at all except the oldest age in spite of significant life-shortening after exposure at the three younger ages. Proportions of irradiated groups with palpable growths of large size (2.5 cm or more) exceeded those for controls even for the group exposed at 21 months. (auth)

40891 ENERGY DEPENDENCY OF RBE OF NEUTRONS IN THE RANGE 0.43 TO 14.1 Mev EFFECT ON DNA SYNTHESIS ON CELLULAR LEVEL. Tsuya, Akira; Okano, Shigeki (Cancer Inst. Hospital, Tokyo). J. Radiat. Res., 8: 53-64(June 1967).

The relative biological effectiveness of neutron radiation of 0.43, 0.65, 1.0, 1.5, 1.8 and 14.1 MeV was studied, taking the dose for halving the labeling index of ^{3}H-thymidine as an index. Adult female mice of ddN strain and Carworth Farms BNL Stoner strain were exposed to single whole-body radiation of 250 kvp x-ray, ^{60}Co gamma-ray and neutron radiation. The RBE of total bone marrow and red cell precursor for 0.43 MeV neutron is highest 4.1 and 3.6 respectively, with decreasing RBE for lower LET. The RBE of bone marrow is 1.2 for 14.1 MeV fast neutron. It is considered that there exists maximum RBE of neutron in the low energy range of less than 2 MeV. The RBE of 14.1 MeV fast neutron are 1.1 and 1.2 for thymus and spleen, respectively. The RBE of 14.1 MeV fast neutron is 1.8 for the intestine. The highest RBE of the intestine suggests higher radiosensitivity of this organ than others. (auth)

40892 POPULATION KINETICS OF CELLS IN TISSUE CULTURE INCUBATED AT LOW TEMPERATURE. Shapiro, I. M.; Lubennikova, Emma I. (Inst. of Animal Morphology, Moscow). Exp. Cell Res., 49: 305-16(Feb. 1968).

Experiments were carried out on cultures of Chinese hamster fibroblasts grown at 37°C and placed at logarithmic phase in an incubator at 6, 15, or 25°C. In cultures maintained for 24 h at 6 and 15°C, the progress of cells through the mitotic cycle stopped. Cells remained attached to the glass for at least seven days of incubation at 6, 15, or 25°C. The number of cells per flask at 15 and 17°C did not change. Cell division was arrested in metaphase at 6 and 15°C. At 25°C, the rate of cell flow from G1 to S was 40 times less and the duration of G2 was 10 times greater than the respective values found at 37°C. The block at metaphase was overcome at 25°C. A partial synchronization of cells in G1 phase occurred 4 days after incubation of the cultures at 25°C. The movement of cells through the cycle and their division were restored quickly at 37°C. Interphase death of x-irradiated cells did not occur when cultures were maintained at 15°C. To distinguish cells at different phases of the life cycle, labeling with ^{3}HTdR followed by cultivation of cells until metaphase in a medium containing ^{3}HTdR in a concentration approximately two to three orders less than that used for labeling was effective. The possible applications of model of cell population stabilized in vitro with incubation at low temperatures are discussed. (auth)

40893 SPATIAL AVOIDANCE IN ALBINO RATS AS A FUNCTION OF POSTIRRADIATION CONFINEMENT. Schuckert, Robert F. (Univ. of Tennessee, Knoxville). J. Genet. Psychol., 112: 175-82(June 1968).

A backward conditioning paradigm was used in an effort to examine the effectiveness of postirradiation stimuli to serve as the unconditioned stimulus in the establishment of conditioned spatial avoidance. While the data indicated the presence of conditioned spatial avoidance, it could not be attributed to the effects of irradiation. Probable sources for the conditioning effect were discussed, and methodological issues were raised. Suggestions were made for future research design. (auth)

40894 PRETUMOR CHANGES IN MICE OVARIES AFTER THE EFFECT OF IONIZING RADIATION. Gubareva, A. V. (Radiological Inst., USSR Ministry of Public Health, Moscow). Vop. Onkol., 14: No. 5, 80-6(1968). (In Russian).

During a year period following the effect of ionizing radiation in a castration dose (200R) serial sections of ovaries of mice were studied. Ovaries of irradiated mice in the mentioned period undergo successive changes that are in accordance with the scheme of blastomogenesis stages elaborated in detail by L. M. Shabad. Thecal tissue and germinal epithelium play the leading role in repair of ovarian tissue in irradiated mice. (auth)

40895 RESEARCH ON VISCERAL LESIONS OBSERVED IN MICE AND RATS EXPOSED TO ULTRASHORT WAVES. SPECIAL STUDY OF THE EFFECTS OF THESE WAVES ON THE REPRODUCTION OF THESE ANIMALS. Miro, Luis; Loubiere, Robert; Pfister, Andre. Rev. Med. Aeronaut. (Paris), 4: 37-9(May-June 1965). (In French).

A study was made of the action of ultra-short waves when the average power emitted was not sufficient to raise the temperature of the animal more than 1°C (i.e., to cause death or serious injury). The emitter used produced a frequency of 3105 MHz ± 15 MHz, with an approximate wavelength of 10 cm. The capacity of the emitter was 580 KW ± 20 KW, but it was modulated to produce an average power of only 34.8 KW ± 1.2 KW. Irradiation was done in an echo-free chamber where the average density of hyperfrequency energy was 0.008 ± 0.003 W/cm^{2} and the energy of each impulse was about 130 ± 50 W/cm^{2}. Under these conditions the temperature of the animals was not increased by more than 0.5°C. In the first experiment, Swiss mice and Wistar rats were exposed for 190, 300, and 450 hr. The only effect observed at autopsy was seen in the spleen, indicating a slight hyperplasia of the reticulohistiocyte system. A study was then conducted to determine possible effects on fecundity. When male or female mice were irradiated before mating, there was no evident effect either on the young or on the gonads. It was concluded that this type of radiation at the power levels and exposures used was not hazardous, for example, for personnel in radar maintenance. (BBB)

40896 PHAGOCYTIC ACTIVITY OF NEUTROPHILS IN WORKERS CHRONICALLY EXPOSED TO IONIZING RADIATION. Gribova, I. A. (Inst. of Occupational Hygiene and Occupational Diseases, Moscow). Gig. Tr. Prof. Zabol., 9: 16-20(Mar. 1965). (In Russian).

Effects of radiation on two groups of occupationally exposed workers are reported. In the 1st group the 102 less exposed workers were employed in accelerator units and research requiring handling of various radioisotopes. The 2nd group was comprised of 93 more heavily and constantly exposed workers, who for 1 to 25 yr of their employment were subjected to various doses of x rays and γ rays, including Rn inhalation. The findings in the 1st group revealed a tendency toward a decrease in the absolute number of neutrophils, although the phagocytic activity of neutrophils in response to killed cultures of Staphylococcus aureus was not significantly affected. The 2nd group showed a distinct neutropenia. The number of neutrophils was below 2500 per mm^{3} in 44.1% of the investigated subjects, as compared with 10.7% in controls. Also the phagocytic capacity of neutrophils for Escherichia coli was reduced in some cases. Changes in phagocytic reactivity under the effects of radiation may be one mechanism responsible for decrease of the body's resistance to infection. (BBB)

40897 CHINESE HAMSTER CELL MONOLAYER CULTURES. II. X-RAY SENSITIVITY AND SENSITIZATION BY 5-BROMODEOXYCYTIDINE IN THE EXPONENTIAL AND PLATEAU PERIODS OF GROWTH. Stewart, J. R.; Hahn, G. M.; Parker, V.; Bagshaw, M. A. (Stanford Univ., Palo Alto, Calif.). Exp. Cell Res., 49: 293-9(Feb. 1968).

Survival following x irradiation of HA2 Chinese hamster cells in monolayer culture during various periods of growth was described. Relatively small changes in D_0 and $\bar{n}$ occurred as culture age increased, and at 72-hr exposure to 5×10^{-5} M 5-bromo-2'-deoxycytidine (BCdR) produced marked radiosensitization of cells from cultures in exponential growth. With cells from transition and plateau period cultures similarly treated, biphasic survival curves were obtained, demonstrating that only part of

the cell population became sensitized. The size of this fraction of sensitized cells agreed with predictions based on measured cell renewal in plateau period cultures. Monolayer cell culture in the plateau period of growth is proposed as a useful in vitro model for in vivo tumor cell behavior. (auth)

40898 ELIMINATION OF MALE ASCARIDIA GALLI (NEMATODA) BY X IRRADIATION OF EMBRYONATED EGGS. Ruff, M. D.; Hansen, M. F. (Kansas State Univ., Manhattan). J. Parasitol., 53: 1285-7(Dec. 1967).

Studies on the development of Ascaridia galli from 10-KR x-irradiated embryonated eggs indicated that a complete absence of male worms was due to their elimination rather than to sex reversal. Elimination of males occurred no later than 10 days postinfection, the earliest stage at which worms could be sexed by current methods. Results of hatching x-irradiated embryonated eggs in vitro indicated that under the conditions used potential male larvae were capable of freeing themselves from the eggshell. If only females had hatched in the irradiated groups, the number of worms should have been half that of the controls because the sex ratio of A. galli is nearly 1:1. (BBB)

40899 EFFECTS OF X RADIATION ON GONADS AND SURVIVAL OF OOCYTES IN EMBRYOS OF BUFO BUFO. Di Grande, Foscarina. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 43: 393-400(Nov. 1967). (In Italian).

Irradiation of Bufo bufo whole embryos caused a complete or almost complete destruction of germ cells. Nevertheless in the genital ridges many somatic cells were preserved. The latter particularly abounded in cephalic tract of genital ridges, and they kept their normal power to induce the scattered residual germ cells to differentiate into oocytes. (auth) (TSS)

40900 EFFECT OF RADIATION ON THE PROGENY OF MICE FOLLOWING EXPOSURE IN YOUNG AGE; AN ATTEMPT TO INFLUENCE HEREDITARY INJURY. Baev, I. A. Rentgenol. Radiol., 7: 92-8(1968). (In Russian).

The effects of sublethal doses (525 R) of x radiation on the progeny of male mice irradiated when 14 days old were studied. Half of the animals were protected by 3-3′-dithiobispropioamidine. The genetic changes were followed for three generations. It was found that the direct influence of irradiation during youth consisted of retarded growth, loss of reproductive capacity (in 40% of the male and 100% of the female animals), and greying of the hair. Hereditary injury was manifested by a reduced number of newborn infants, increased proclavity towards cannibalism on the part of the mother, nanism, retardation of growth, sterility, and high postnatal mortality. Propioamidine reduced the number of radioinduced genetic injuries. (auth)

40901 A CONTRIBUTION TO THE QUESTION OF INTERINDIVIDUAL DIFFERENCES IN LEUCOCYTOPENIA AFTER WHOLE-BODY IRRADIATION OF MICE WITH SMALL DOSE OF X-RAYS. Vacha, J.; Pospisil, M. (Inst. of Biophysics, Brno). Stud. Biophys., 2: No. 1, 19-26(1967).

A test of regulatory balance of the individual, based on the observations of the dynamics of urine Na/K ratio was used for prediction of individual differences in the leucocyte response of mice irradiated with 40 R. The individuals with the median values of Na/K ratio fluctuations (regulatory balance) exhibit before as well as after irradiation the highest leucocyte values. Furthermore the importance of Wilder's law of initial values in determining the individual differences in postirradiation leucocyte decrease is described. (auth)

40902 INDUCTION OF CLEFT PALATE BY MEANS OF INTERNAL RADIATION. Goljan, Kenneth R. (Univ. of Louisville School of Dentistry, Ky.). J. Dent. Res., 47: 500(May-June 1968).

Cleft palate was induced in 45% of the offspring of mice subjected to internal β irradiation from ^{3}H-thymidine injected on the 14th day of pregnancy. All clefts of the palate were without lip involvement. This type of cleft formation has not been reported to occur spontaneously in mice, as does cleft palate associated with cleft lip. Since thymidine is specific for DNA, it was concluded that radioinduced chromosome breaks were involved in induction of cleft palate. An experimental model for the effect of internal radiation on palate morphogenesis is presented. (C.H.)

40903 FETAL HAZARDS DUE TO X-RAY DIAGNOSIS DURING PREGNANCY. Tabuchi, Akira; Nakagawa, Shigeru; Hirai, Tsuyoshi; Sato, Hideo; Hori, Ippei; Matsuda, Michinori; Yano, Kimio; Shimada, Katsunobu; Nakao, Yukinori (Hiroshima Univ.). Hiroshima J. Med. Sci., 16: 49-66(Mar. 1967).

Possibilities of radiation effects appearing in children irradiated in utero during diagnostic x-ray procedures and preventative measures that can be taken to reduce such exposure are discussed. Other than natural radiation sources, diagnostic x-ray exposure is the most frequently encountered source of radiation, and therefore much attention has been paid to radiation hazards by geneticists and clinicians. Radiation hazards are considered in two categories, namely, somatic hazards and hereditary hazards. To decrease the exposure of fetuses and the gonads of the mother, improved methods of x-ray diagnosis are examined. Methods of x-ray diagnosis considered to give the lowest doses of exposure are shown in a table. After fetal exposure of more than 10 R, artificial termination of pregnancy should be performed. Fetal exposure during the first two months of pregnancy should be limited to 1 rem or less, so that the permissible dose of abdominal exposure of mature women occupationally exposed to radiation (such as nurses) should be restricted to less than 1.3 rem in 13 weeks. Roentgenography of the lower abdomen and pelvis of mature women should be performed within 10 days from the beginning of menstruation, at which time pregnancy can be definitely ruled out. (BBB)

40904 ^{90}Sr AND INTRAUTERINE DEVELOPMENT IN THE RAT. Hopkins, B. J.; Casarett, G. W.; Tuttle, L. W.; Baxter, R. C. (Univ. of Rochester, N. Y.). J. Embryol. Exp. Morphol., 17: 583-91(June 1967).

Single doses of ^{90}Sr (191 or 382 μCi) were injected intravenously in pregnant rats on the 2nd or 10th day postconception and the developing offspring were observed for deleterious effects on the 20th day postconception. Injection of either dose on the 2nd day caused a significant increase in intrauterine mortality and fetal growth retardation (stunting) but no increase in morphological defects other than stunting. Injection on the 10th day caused little or no increase in mortality or growth retardation following a dose of 191 μCi, and only slight increases after 382 μCi. However, gross morphological defects of various types were observed at both dose levels, but fewer varieties of defects at the lower dose. The most common defects were, in decreasing order of frequency, taillessness, retarded growth, reduced eye volume, skeletal defects, and interscapular depression. The radiation dose rate to both uterus and embryo was high soon after injection, then declined to low levels. A second peak in dose rate to the embryo occurred during late fetal life while that to the uterus remained low. The deleterious effects observed appeared to be dependent upon the total dose of ^{90}Sr and gestation age at time of injection. (BBB)

40905 LATE FUNCTIONAL AND COSMETIC RESULTS OF TREATMENT OF EYELID TUMORS. Halnan, Keith E. (Western Infirmary, Glasgow); Britten, M. J. A. Brit. J. Ophthalmol., 52: 43-53(Jan. 1968).

Incidence of side-effects and injuries from irradiation was investigated in 104 patients receiving x-ray therapy or Rn implants for treatment of eyelid tumors. The complications after treatment are summarized. Minor complaints included irritation of the scar in hot weather, intermittent slight blepharitis, and discomfort from the weight of spectacles resting on the scar. Other complications are listed in a table. Conjuctivitis did not last for longer than a year. The Rn seed implants caused recurrent attacks of itchiness and dryness in 2 patients, and another had recurrent trichiasis and entropion following primary excision repaired by a graft. Five cases of delayed necrosis after x irradiation all healed within 2 months and suffered no recurrences. The incidence of blockage of the lacrimal passages and of epiphora was high. Deformity of the lid margin after primary treatment required surgical correction in 1 case, and radiation cataracts (mostly minor and not affecting vision) were confined to the same side as the tumor and to the group treated by Rn seed implants except for a single case treated with x-rays. Here, failure to shield the left eye in a case of tumor at the right inner canthus resulted in a sector-shaped radiation cataract of the medial part of the left lens. Further details of the radiation cataracts are given. Shielding the eye from harmful doses of x rays appeared to have been successful and the only radiation cataract found in this group occurred in an unshielded contralateral eye. The necessity for shielding the lens is emphasized by the relatively high incident of radiation cataract following treatment by Rn seed implant, where shielding of the eye was impossible. These and the more frequent occurrence of other complications emphasize the unsuitability of this method of treatment in this site. The late cosmetic and functional results suggested that a minimum safe area should be irradiated, taking a margin of normal tissue of at least 5 mm and up to 10 mm wide all round the visible tumor. (BBB)

40906 MALIGNANCY AND OTHER INJURIES FOLLOWING THOROTRAST ADMINISTRATION: FOLLOW-UP STUDY OF 147 CASES IN JAPAN. Mori, Takesaburo (Yokohama City Univ., Japan); Sakai, Toshiharu; Nozue, Yushin; Okamoto, Takashi; Wada, Tatsuo; Tanaka, Toshihiko; Tsuya, Akira. Strahlentherapie, 134: 229-54(Oct. 1967).

Results are reported from an extensive follow-up study of 147 war-wounded ex-servicemen, selected from the records of four former army hospitals, who were administered Thorotrast (thorium dioxide) for diagnostic purposes 22 to 27 years prior to the initiation of the study. Comparison of the subject cases with two control groups selected from the same sources, respectively consisting of 160 individuals who were injected with non-radioactive roentgenographic contrast medium and 1,679 persons who were not given any contrast medium, and with the average Japanese male population in the same age bracket, showed that the mortality rate attributable to malignant hepatic tumors and cirrhosis of the liver in the Thorotrast-administered group was significantly higher than in the control groups. (auth)

40907 INVESTIGATIONS ON THE SIGNIFICANCE OF THE NUCLEAR SEGMENT INDEX OF NEUTROPHIL GRANULOCYTES IN THE ESTIMATION OF RADIATION; HEMATOLOGICAL CHANGES IN PERIPHERAL BLOOD. zur Horst-Meyer, Horst; Mau, Sigrid; Petroff, Christoph (Humbolt-Univ., Berlin). Strahlentherapie, 134: 255-62(Oct. 1967). (In German).

Observations on patients during ^{60}Co γ therapy lead to the conclusion that the nuclear segment index of the neutrophil granulocytes is sensitive to very low and greatly fractionated radiation doses. In the case of less fractionated and higher doses of local irradiation, a decrease of the absolute number of the granulocytes in the peripheral blood was observed, in addition to an increase of the segment index. The picture of this radiation-induced granulocytopenia can be superimposed with an infection (cystitis, proctitis) which can be recognized by the decrease of the nuclear segment index and which is based upon a release of lesser segmented granulocytes from the bone marrow. In the case of extensive combined damages, the re-increase of the granulocytes in the peripheral blood can be absent because of increased consumption; therefore, a decrease of the nuclear segment index of the neutrophil granulocytes is the only result. (auth)

40908 RADIOIRON INCORPORATION IN ERYTHROCYTES AFTER FRACTIONATED OR PROTRACTED WHOLE-BODY IRRADIATION. Koch, Ruprecht; Seiter, Irma; Moenig, Hans (Univ., Freiburg i. B.). Strahlentherapie, 134: 272-8(Oct. 1967). (In German).

The threshold dose for fractionated and protracted whole-body x irradiation that resulted in a significant disturbance of erythropoiesis was determined in mice using the ^{59}Fe utilization test. Irradiations were done over a period of 6 weeks. When x irradiation was done twice per week, the threshold dose was 50 R per day (600 R total dose in 6 weeks). When irradiation was done five times per week, the threshold dose was 40 R (1200 R total dose); while in the case of protracted irradiation with ^{60}Co γ rays, the threshold dose was 96 R per day (2880 R total dose). (auth)

40909 THE INFLUENCE OF WHOLE-BODY IRRADIATION ON SERUM PROTEIN, PROTEIN-BOUND HEXOSE, AND HEXOSAMINE AS WELL AS SERUM TRANSAMINASE IN RATS. Varga, Laszlo; Braun, Heribert; Hornung, Guenter (Univ., Wuerzburg, Ger.). Strahlentherapie, 134: 284-92(Oct. 1967). (In German).

Total protein, hexose, hexosamine, and the enzyme activity of plutamic-oxalacetic transaminase and glutamic-pyruvic transaminase were determined in serum of rats at different intervals after whole-body x irradiation with 600 R. Moreover, the serum proteins were separated by means of paper electrophoresis. The total protein values of the serum were significantly decreased one hr and six days after irradiation; they were significantly increased three and 12 days after irradiation. The albumin and γ-globulins were decreased, while the α-globulins were increased. The concentration of hexose and hexosamine showed an increase eight to 12 days after irradiation in some animals; in other animals normal values were observed. A relation between the behavior of the transaminase and hexosamine or hexose could not be observed. (auth)

40910 MUTATION RATES AND MORTALITIES AFTER X IRRADIATION OF THE EARLY DEVELOPMENT STAGES OF DROSOPHILA MELANOGASTER. Petermann, Urs B. (Eidgenoessische Technische Hochschule, Zurich). Mutat. Res., 5: 397-410 (May-June 1968). (In German).

Selected stages of newly laid inseminated eggs of Drosophila melanogaster were x-rayed with 500 R. The investigated phase of development lasted about 16 min. During this period the egg nucleus goes through the late stages of meiosis and forms the maternal pronucleus. Simultaneously the sperm head transforms into the paternal pronucleus. By using a new experimental arrangement it was possible to register in the same experiment three types of mortality as well as the recessive lethals (including orthodox and Y-suppressed lethals) in the maternal and paternal X-chromosome separately. The radiosensitivity for early and late embryonic, as well as for postembryonic mortality, changes during the development. For each of the three types of mortality this change is correlated in a similar way to the nuclear division cycle. Irradiation of anaphase/telophase of the second meiotic division gave maximum mortalities. Pronuclei on the other hand are least sensitive. Concerning the induction of recessive lethals in the maternal X-chromosome, all meiotic and pronucleus stages so far investigated were equally sensitive (average rate 2.9%). Contrary to this, the radiosensitivity of the paternal X-chromosome changed significantly during the transformation of the sperm head into the paternal pronucleus. The average rate of sex-linked lethals of sperms irradiated in the egg 1 to 10 min after egg deposition was 4.75%. This rate was significantly higher than the average rate of 2.25% determined for the older stages of the sperm (irradiated 10 to 16 min after egg deposition) and the rate of 2.9% mentioned above. For each irradiated stage the lethal factors found in both X-chromosomes were added to give the total rates of lethals. When these were compared with the corresponding total mortalities it became evident that the induction of lethal factors and the induction of mortality are correlated in a different way to the nuclear division cycle. (auth)

40911 NON-RANDOM LOCALIZATION OF LETHALS IN DROSOPHILA. Falk, Raphael; Lifschytz, Eliezer (Hebrew Univ., Jerusalem). Mutat. Res., 5: 411-16(May-June 1968).

Inconsistencies in allelism tests were observed among the lethals obtained from populations of Drosophila melanogaster with x radiation histories. These were interpreted as being caused by a series of partially overlapping deletions clustered within short segments of the chromosome. Lethal mutants in these segments would have been protected from effective elimination by natural selection if they were completely, or nearly completely recessive. If inversions with breakage points in these segments persisted longer in populations, the non-random distribution of breakage points of inversions from natural populations could be understood. (auth)

40912 THE DEPENDENCE OF RBE ON THE ENERGY OF FAST NEUTRONS FOR SPERMATOGONIA DEPLETION IN MICE. Bateman, John L.; Johnson, Horton A.; Bond, Victor P.; Rossi, Harald H. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). Radiat. Res., 35: 86-101(1968). (BNL-11847).

The depletion of spermatogonia in mice, as evidenced by the reduction of (subsequent) resting primary spermatocytes, was used to assay the biological effectiveness of radiations differing in quality and dose rate. Both 250-kVp x rays and ^{60}Co gamma rays yielded 50% effective doses near 40 rads, and no dose-rate effect for the former could be demonstrated in the range of 0.2 to 100 rads/min. Monoenergetic neutrons had ED_{50} values of 3.7 rads at 0.43 MeV and 15 rads at 14 MeV. Neutrons of intermediate energies yielded ED_{50}'s between these two values. No influence of dose rate at the 50% level of effect could be demonstrated with 0.62-MeV neutrons in the range of 0.015 to 1.5 rads/min or with 14-MeV neutrons in the range of 0.15 to 15.0 rads/min. A comparison of minimal gross sensitive volumes (gsv), as obtained from the inactivation constants, with measurements of spermatogonia in fresh preparations showed the gsv to be similar to the spermatogonia cell volume. (auth)

40913 EFFECT OF CELL CONCENTRATION DURING IRRADIATION AT LOW OXYGEN TENSION ON SURVIVAL OF MOUSE ASCITES TUMOR CELLS. Evans, T. C.; Hagemann, R. F.; Leeper, D. B. (Univ. of Iowa, Iowa City). Radiat. Res., 35: 123-31(1968).

Sarcoma 180 and Ehrlich ascites tumor cells were irradiated in vitro as a 1:10 or 1:1000 suspension in normal saline. During irradiation, metabolism was inhibited by maintaining the cells at 0°C. Dose-effect curves for survival and reproduction were determined during the exponential growth phase (9 days) after intraperitoneal inoculation of approximately 4000 cells. Cells irradiated in low oxygen environment suffered more injury in the diluted (1:1000) than in the more concentrated (1:10) suspension. The results at 9 days were confirmed in their general aspects by ultimate survival (percentage of tumor takes). Dilution of the cell population during exposure was found to be a factor that was distinguishable from that of the oxygen effect. (auth)

40914 EFFECT OF IONIZING RADIATION ON CELL DIVISION IN AN AMOEBOID CELL. Little, John B.; Chang, R. Shihman (Harvard School of Public Health, Boston). Radiat. Res., 35: 132-46(1968).

The radiosensitivity of an amoeboid cell is described. The cell which appears closely related to the genus Hartmannella of small free-living amoebae, carries certain transferable factor(s) capable of inducing specific degeneration in cultured human cells. The terminal dilution principle was adapted as an assay of single-cell

survival in amoeboid cell cultures, allowing determination of surviving fractions as low as 10^{-5}. The survival curve has a very prominent shoulder, yielding a threshold dose of 600,000 rads with a D_0 on the linear portions of the curve of 27,000 rads. At doses up to 600,000 rads there was a dose-dependent division delay. The DNA content of the amoeboid cells is about 10% of that in an established line of human cells; on the basis of DNA content they are highly radioresistant. The unusually large shoulder and threshold dose may reflect a highly efficient repair mechanism. These cells would appear to be an unusual interesting system in which to study further the mechanisms of cellular radiation damage. (auth)

40915 EXTRACORPOREAL IRRADIATION OF BLOOD IN MAN: RADIATION RESISTANCE OF CIRCULATING PLATELETS. Greenberg, M. L.; Chanana, A. D.; Cronkite, E. P.; Schiffer, L. M.; Stryckmans, P. A. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 35: 147-54(1968). (BNL-11880).

Circulating platelets, unlike megakaryocytes, are highly radioresistant. The platelets from five leukemic patients receiving extracorporeal irradiation of the blood were labeled with ^{51}Cr. No effect was observed on the life span of the platelets, their ability to take up ^{51}Cr, or their ability to circulate shortly after autotransfusion. Platelets from a nonleukemic patient were similarly resistant to radiation (up to 75,000 rads) given in vitro. Clinical observations of platelet levels in our patients also suggest a lack of radiation damage. The doses of radiation delivered to platelets by extracorporeal irradiation of the blood do not seem to be a limiting factor for this form of treatment. (auth)

40916 IMMEDIATE MODIFICATIONS OF THE VISUAL EVOKED POTENTIALS IN THE ADULT RABBIT EXPOSED TO NON-LETHAL WHOLE-BODY γ IRRADIATION. Court, Louis; Magnien, Patrick; Avargues, Marcel; Laget, Paul (Centre des Recherches du Service de Sante des Armees, Paris. CEA, Fontenay-aux-Roses, France. Faculte des Sciences, Paris). Compt. Rend., Ser. D, 266: 1160-2(Mar. 11, 1968). (In French).

In the rabbit exposed to a non-lethal whole-body γ irradiation of 400 rads, modifications were observed in the elements of the visual evoked potentials; the sharpest appeared to be the significant increase of the latency and of the delays of the different components. (tr-auth)

40917 BIOLOGICAL INFLUENCE OF SUPERSONIC FLIGHT: RADIATIONS. Cartier, Maurice (Centre National de la Recherche Scientifique, Paris). Tech. Sci. Aeronaut. Spatiales, No. 4, 461-6(July-Aug. 1966). (In French).

An introduction to radiation and its interaction with appropriate materials was given. A review of radiative meteorology began with the H atom in classical physics, then treated the hydrogen molecule in wave mechanics, progressed to a treatment of the sun's interactions with the earth, with a discussion of whistlers, lunar echoes, and gegenschein. The nature of radiation in the stratosphere and the cosmic environment was developed, and correlation with solar activity sketched. The use of spectroscopy to study acceleration of particles in the terrestrial magnetic field was indicated. Several protection schemes against solar radiation were suggested. Interaction of radiation with matter, particularly living material, was briefly outlined. The action of chemical protecting agents, especially the sulfur-containing amino acids, was touched upon, and quotations from other workers on exposure at 25,000 m were given: an accumulation of 0.85 rem for 500 hr exposure in a vehicle traveling 1000 hr per year was calculated by Struhing. (BBB)

40918 CRYPT CELL POPULATION CHANGES IN THE RAT INTESTINE DURING INJURY AND REPAIR AFTER FAST NEUTRON IRRADIATION. Baker, D. G.; Hopper, A. F. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 34: 555-69(1968).

Rats receiving 200, 300, and 400 rads of fast neutron irradiation and pair-fed controls were given single injections of tritiated thymidine (μCi/gm) and studied at time intervals up to 96 hours postexposure. Autoradiography of intestinal crypts isolated from the first, middle, and last 10% of the small intestine was used to determine the grain count, mitotic index, and labeling index. In the same regions, measurements of crypt size, mucosa nitrogen, and water concentrations were made. There was a severe inhibition of proliferative activity by 6 hours postirradiation at all dose levels. Some recovery had begun at 12 hours, and the mitotic index but not the labeling index returned to the level of the controls by 24 hours. In the 200-rad and 300-rad groups, the values of mitotic index, crypt cell count, and labeling index exceeded the values found in the control animals by the fourth day. The first tenth of the small intestine appeared to be the faster to recover from the irradiation. The mucosa of irradiated animals had a higher water content and lower nitrogen concentration than controls. For both nitrogen and water, the differences between irradiated and controls were maximum at 24 and 48 hours postirradiation. At all doses of irradiation, total mucosa mass was first reduced, then increased to higher than preirradiation values by the fourth day after exposure. Food restriction to the pair-fed controls resulted in a decrease of water and nitrogen concentrations and the number of cells per crypt compared to animals offered food ad libitum. (auth)

40919 DOSE-SURVIVAL CURVES OF FRACTIONATED IRRADIATION IN MICE. Kiga, Masami; Tazaki, Isao (Showa Univ., Tokyo). J. Radiat. Res., 8: 72-9(June 1967).

An analysis was carried out to explain the shape of survival curves in fractionated irradiation. The dose that seemed to remain in the irradiated animals at the time of subsequent exposure was estimated from (differential) survival decrease by the exposure. Single-dose survival curves of the experimental animals were the guide to the estimation. The apparently remained dose in animals surviving previous dose at the time of each successive exposure assumed to be residual dose or RD, which was denoted from residual damage to which not differential but total survival decrease was referred. Recovery rate was calculated from our experiment of whole body irradiation in mice. The dose consisted of residual dose at the time of i-th exposure together with the i-th exposure decreasing during the time-interval to the residual dose at the time of the subsequent $i+1-th$ exposure, indicated the recovery rate being independent to dose size. However, the recovery did not seem exponential to interval days; two days recovery seemed most rapid. (auth)

40920 THE EFFECTS OF ^{60}Co IRRADIATION ON COMPENSATORY RENAL HYPERTROPHY IN THE RAT. Bogatzki, M.; Evers, R.; Schnepper, E.; Schuetz, J. (Univ., Muenster, Ger.). Ger. Med. Mon., 12: 283-(June 1967).

Biochemical changes induced by ^{60}Co γ irradiation at therapeutic doses of 900 and 4500 R to the rat kidney undergoing hypertrophy after contralateral nephrectomy were assessed. The experiments involved estimation of the concentrations of RNA, DNA, and protein in the irradiated hypertrophic kidney and microscopic examination of the kidney tissue. Irradiation was followed in both groups by characteristic rhythmic fluctuations in both RNA and DNA concentrations. Ten days after irradiation with 4500 R the kidney began to lose protein concurrently with microscopic evidence of progressive parenchymatous necrosis and renal fibrosis. In view of these observations it was recommended that caution be used in irradiation of the kidney, especially if the contralateral kidney was removed or nonfunctional. (BBB)

40921 DISSOCIABILITY OF DEVELOPMENTAL PROCESSES IN THE MORPHOGENESIS OF THE EAR IN AMBYSTOMA, AS REVEALED BY X-RAY DAMAGE. Platt, Jean (Univ. of Pennsylvania, Philadelphia). Anat. Rec., 160: 143-52(Jan. 1968).

Ambystoma maculatum eggs were separated at Harrison's stage into three groups of eight and then maintained at 8°, 14° and 20°C, respectively, until stage 28. The stage 28 eggs were x irradiated at a dose of 600 R and a right ear vesicle was substituted for that of a nonirradiated complement. Subsequent development of the irradiated grafts, all reared at 20°C, was compared. Within this range of temperatures, hypothermia alone had no effect on final ear development; every left ear in all groups developed normally. Development of irradiated grafts in the 8° group was decidedly more abnormal than in either 14° or 20° groups. With the exception of the 8th ganglion, development of the grafts in 14° and 20° groups was approximately the same. On the basis of 8° = 1, average developmental ratings for the three groups were as follows: size, 1:2:2; differentiation, 1:2:2; ganglion, 1:2:5. Thus the chronologically older ear was more radiosensitive than the younger despite morphological parity among groups at time of irradiation. This suggested that prolonged hypothermia could dissociate in time the invisible or biochemical processes of development from the purely morphological; the metabolic pace was less retarded than the morphological. (BBB)

40922 TREATMENT OF LYMPHEDEMA OF THE EXTREMITIES FOLLOWING SURGERY AND RADIOTHERAPY. Valtonen, Erkki J. (Univ. Central Hospital, Helsinki). Ann. Chir. Gynaecol. Fenn., 56: 144-8(1967).

A treatment program for patients with lymphedema of the extremity due to radical surgery and radiotherapy is described. The number of patients suffering from lymphedema of the extremities after radiotherapy is high. Most cases of lymphedema of the upper extremity occur after radical mastectomy combined with radiotherapy. Edema in the lower extremities is caused by evacuation of inguinal and/or deeper lymph glands, combined with postoperative radiotherapy. The most common reasons for this therapy are gynecologic malignancies and melanomas in the skin of the lower extremities. The results of the treatment described show that $\frac{1}{4}$ of the patients obtain no relief, about $\frac{1}{2}$ improve slightly and the remaining $\frac{1}{4}$ show marked improvement. (BBB)

40923 WEAK LIGHT FROM ORGANISMS AND MITOGENIC RADIATION. Hoefert, Manfred (Max-Planck Inst. for Carbon Research, Muelheim, Ger.). Strahlentherapie, 135: 103-8(1968). (In German).

A very weak emission of light (spectral range from 350 to 540 nm) from biological material was measured in vivo and in vitro with sensitive detectors by several research teams during the past years. Radical reactions during the course of autoxidative chain reactions in organic substances were responsible for this chemiluminescence. The oxygen influence upon intensity and duration of the luminescence was especially clear in the case of irradiation experiments done with isolated brain of rats. The mitogenic radiation in the short wave uv-range could not be determined unobjectionably, even in our own experiments. There was no reason to assume that there was a close relationship between both phenomena. (auth)

40924 EFFECT OF ERYTHROPOIETIN ON TRANSPLANTED HEMATOPOIETIC TISSUE. O'Grady, L. F.; Lewis, J. P.; Lange, R. D.; Trobaugh, F. E. Jr. (Univ. of Illinois, Chicago. Univ. of Tennessee, Knoxville). Amer. J. Physiol., 215: 176-82(July 1968).

Hematopoietic colonies produced in lethally irradiated mice by the injection of isogenic bone marrow were used to study the influence of erythropoietin on the growth and development of hematopoietic tissue. Groups of mice were exsanguinated on each of 10 days following lethal irradiation. Endogenous erythropoietin was not detectable in the plasma until after the 7th day postirradiation, several days after the hematopoietic graft was established. In animals that were irradiated at 750 R, and injected with 15,000 isogenic bone marrow cells, the amount of erythropoietin available to the hematopoietic graft was varied by hypertransfusion, administering exogenous erythropoietin, or administering erythropoietin antiserum. As plethora was increased there was a decrease in the size and number of erythroid colonies. With sufficient plethora, erythroid colonies disappeared but there was no change in nonerythroid colonies. Exogenous erythropoietin stimulated the reformation of erythroid colonies, the number and size of which was dependent on the dose of erythropoietin administered. Antiserum to erythropoietin caused a decrease in the size and number of erythroid colonies. (auth)

40925 RELATIVE BIOLOGICAL EFFECTIVENESS OF 15 MeV BETATRON X-RAYS AND 200 kV X-RAYS ON THE BONE MARROW OF MICE. Nakatsuka, Haruo; Fukui, Yoshinori; Murano, Tosiaki; Fujino, Moriji (Osaka City Univ.). J. Radiat. Res., 7: 123-33(Sept.-Dec. 1966).

The relative biological effectiveness (RBE) of 200 kV x rays and 15 MeV Betatron x rays was determined using nucleated bone marrow cell count as the criterion of radiation effects. The RBE for 15 MeV betatron x rays versus 200 kV x rays was found to be 0.72. When a definite method of dosimetry for such high energy x rays is established, the RBE value tentatively derived in the present study may be subjected to changes. (auth)

40926 RADIATION-INDUCED CELLULAR CHANGES IN TRAUMATICALLY INJURED RAT SPINAL CORD. Ticer, James Winford. Fort Collins, Colo., Colorado State Univ., 1967. 102p.

Thesis.

An investigation was undertaken to define the comparative radiation sensitivity of DNA synthetic and proliferative ability of the various cell types involved in spinal cord scar formation. Left dorsal cordotomy at the 11th thoracic vertebra was performed in mature female rats. Local exposures of 1,000 R of 280 kVp x rays were made within 10 min, 12, 24, 36, or 48 hours after injury. Tritium-labeled thymidine (1μ Ci/g body wt) was injected intravenously one hr before death and necropsy examination 5, 18, or 30 days after surgery. Hemotoxylin stained sagittal sections (5μ) of the spinal cord were prepared for radioautographic examination. The parameters of magnitude and duration of changes in cell numbers and numbers of cells incorporating tritium-labeled thymidine were determined for neuroglia, fibroblast, macrophage, and endothelia cells. Irradiation modified the cellular composition of the developing scar tissue. These changes were due to a delay of proliferation in neuroglia, fibroblast, and endothelial cell populations. A concomitant suppression of the number of cells incorporating tritium-labeled thymidine occurred in five day old irradiated lesions. The magnitude and duration of these delays varied with the cell type and the time of irradiation after injury. These changes indicate that neuroglia, fibroblast, and endothelial cells proliferate in situ from progenitor cell populations that were in the lesion at the time of irradiation. Macrophage cell numbers and numbers of these cells incorporating tritium-labeled thymidine were not decreased after irradiation. It is, therefore, probable that macrophage cells did not originate from a local progenitor cell population. (Disser. Abstr.)

40927 STUDIES ON THE INCIDENCE AND ETIOLOGY OF LEUKEMIA IN NEW ZEALAND. Gunz, F. W. (Christchurch Hospital, N. Z.). N. Z. Med. J., 65: Suppl., 857-62(Dec. 1966).

The rising incidence of leukemia in New Zealand was reviewed, with an analysis of possible etiologic factors, including ionizing radiations. Leukemia mortality was relatively high in New Zealand, this country being fifth for males in the 24 countries reviewed and second for females, with the incidence rising in both sexes. In a survey, patients with all types of leukemia were interviewed, and questions were asked, among others, about their exposure to such factors as infections, occupational chemicals, drugs, and ionizing radiations. The multiplicity of chemical, physical, and infectious agents to which a modern population was exposed made it likely that survey methods would disclose leukemogens among them only if the agents were extremely active or the population surveyed was larger than that of New Zealand. It was also difficult to obtain corroboration of alleged exposure or nonexposure to drugs, chemicals and similar agents, the more so the more widespread their general use. An exception to the indeterminacy of most agents was medical ionizing radiation exposure. Histories of exposure to radiotherapy were significantly more frequent in the group of leukemia patients surveyed than in the controls. The excess existed only among patients who had had relatively large doses of therapy and who had received it less than 15 yr before the onset of the disease. In contrast to the therapeutic irradiations, diagnostic x rays were not significantly more prevalent in leukemia patients than in controls. However, a few exceptional patients had had multiple x-ray examinations whose total dose lay within the higher therapeutic range. Possibly their disease was radioinduced. Altogether, possibly etiological agents such as a genetic predisposition and exposure to ionizing radiation were discovered in only 5 to 15% of all case histories. Even here they were unlikely to have been the sole causes of the disease, and most of all sporadically occurring cases remained unexplained. (BBB)

40928 ELECTRON MICROSCOPIC STUDY OF THE DEVELOPMENT OF X-IRRADIATED EMBRYONIC PLANARIAN STRUCTURES. Le Moigne, A. (Faculte des Sciences d'Orsay, Essone, France). J. Embryol. Exp. Morphol., 19: 181-92(Apr. 1968). (In French).

Electron-microscopic examination of Polycelis nigra embryos x irradiated after the beginning of differentiation of the rudiments of adult structures was reported. The cells of the rudiments differentiated normally, and showed only local lesions which were repaired. The differentiated tissues were, however, smaller than normal, presumably because of interference with cell proliferation. Undifferentiated cells suffered generalized damage and died. They were absent at hatching in irradiated animals although they were normally present. The young hatchlings lost the capacity to regenerate. It appeared that x irradiation preferentially destroyed undifferentiated cells at this period. These cells provided the neoblasts that were present in the normal hatching. (BBB)

40929 ACUTE RADIATION DAMAGE OF THE SPLEEN AND ITS MODIFICATION BY HYDROCORTISONE. Seki, Masatoshi (National Inst. of Radiological Sciences, Chiba, Japan). Acta Pathol. Jap., 17: 320-3(Aug. 1967).

Male mice of the ddY strain, six weeks of age, were subjected to whole-body x irradiation of 500 R. Two hr after irradiation, degenerative changes were seen in lymphocytes and erythroblasts in the lymph follicles and pulp cords, respectively. The cells showed marked pyknosis of nuclei or aggregation of chromatin at the nuclear membrane. Disappearance of the cytoplasmic membrane with outflow of protoplasmic substance among the neighboring cells was then seen. Mitochondrial vacuolization was common. In the next step, the cells were phagocytized and digested by the reticular cells. After four to six hr, mitoses in lymphocytes and erythroblasts again were seen. Most of them were, however, abnormal types, with chromosome aberrations, that may have resulted in the death of some dividing cells. At the same time, outflow of the myeloid elements of the pulp cords was caused by the increased blood flow from sheathed artery to sinus. The cellular components of the spleen were, therefore, decreased in number and the spleen became smaller. Incorporation of ^{3}H-thymidine into the spleen was markedly decreased. Treatment with hydrocortisone aggravated the decrease in spleen weight and destruction of lymphocytes after irradiation, but adrenalectomy had the opposite effect. However, about 70% of the adrenalectomized mice were dead within five days after irradiation but none of hydrocortisone-treated animals died. (BBB)

40930 SUBACUTE AND CHRONIC HISTOLOGICAL CHANGES IN THE IRRADIATED BONE MARROW. Hashimoto, Michio; Mitsuyasu, Yukishige (Kyushu Univ., Fukuoka). Acta Pathol. Jap., 17: 328-9(Aug. 1967).

To study the pathological effects of irradiation on bone marrow, histological examinations on patients with neoplasms subjected to radiotherapy, atom bomb survivors, and ^{60}Co-irradiated animals were carried out. In atom bomb victims, three stages of injury were investigated: the acute stage two weeks after irradiation, the sub-acute stage at three to five weeks, and the chronic stage at more than five weeks. In 58 patients subjected to local radiotherapy for neoplasms about two weeks to 11 years before autopsy, comparative study of irradiated and nonirradiated bone marrow in the same individual disclosed that the irradiated marrow was more hypoplastic in the hematopoietic elements in 50 (86%) than the nonirradiated marrow. This hypoplasia was considered as a radiation effect. Out of 120 atom bomb subjects exposed within 2 Km from the hypocenter, who survived for 10 yr or more and died of nonhematological diseases (excluding leukemia, hypoplastic anemia), six subjects at autopsy showed bone marrow with irregularly intermingled hyperplastic and aplastic areas. Guinea pigs received 200 to 700 R of whole-body irradiation, 400 to 7000 R of local (hind leg) irradiation, or fractionated (7 × 1000 R twice weekly) local irradiation. In animals that survived after whole-body irradiation with a dose of more than LD_{50}, the bone marrow regained its original hematopoietic activity almost completely in three weeks to one month, with irregularly distributed fat cells seen in the red marrow up to six months later. In the animals subjected to local irradiation with 400, 700, and 1500 R, the irradiated marrow completely regained its original hematopoietic activity in three weeks to one month. In animals given a single local dose of 3000, 5000, or 7000 R the same result was found at about one month, but thereafter, nearly aplastic marrow developed. In animals given 7000 R in fractionated doses, the hematopoietic elements in the irradiated marrow recovered partially in about one month, and thereafter continued to be hypoplastic or aplastic. (BBB)

40931 STUDIES OF THE RELATIVE ROLE OF RADIATION INJURIES AFFECTING SPERMATOZOID AND OVIFORM CELLS IN RADIOBIOLOGY OF THE MULBERRY SILKWORM. Akhalaya, Ya. G. Soobshch. Akad. Nauk Gruz. SSR, 49: 689-93(Mar. 1968). (In Georgian).

Data obtained on γ irradiation effects on gonads of silk worms indicated severe injuries in the nuclear structure of germ cells and cytoplasm. The radiation injuries exhibited a higher death percentage (49.3) of embryos produced by fertilization of an injured ovum by a normal spermatozoid than by a reverse combination that caused embryo death of about 35.0 percents. The same effects were observed in the growth of caterpillar and butterflies. Radiation injuries of spermatozoid inhibited the production of silk and the fertility of the germ cell. (R.V.J.)

40932 RADIATION CARCINOGENESIS WITH SPECIAL REFERENCE TO THE INDUCTION OF OSTEOGENIC SARCOMAS BY INTERNAL AND EXTERNAL IRRADIATIONS. Yokoro, Kenjiro (Hiroshima Univ.). Acta Pathol. Jap., 17: 348-50(Aug. 1967).

A high incidence of osteogenic sarcomas was observed in young adult dd mice following repeated administration of ^{89}Sr (total of 50 to 60 μCi/mouse). The tumors originated predominantly in the long bones such as femur, tibia, and humerus, and occasionally in vertebrae and pelvis after a latency of 250 to 390 days. In some cases, metastases were found in the liver, spleen, lungs, or regional lymph nodes. The deleterious effects of ^{89}Sr on the skeleton were manifested as an early cessation of endochondral ossification at the epiphyseal plate, proliferation of atypical fibrous bone in the metaphyseal region, and sustained depression of the medullary hematopoiesis. The buds of the osteogenic sarcomas were first recognized at ~150 days after the treatment, and were found at the junction of the metaphysis and diaphysis as small foci of atypical large spindle cells which appeared to be derived from the endosteum. The localization of the tumor formation corresponded to the intensity of radioactivity deposited. Radioautographic studies performed at various intervals after administration of ^{89}Sr indicated that the maximum radioactivity shifted, with time, from metaphysis of the distal part to diaphysis. Consequently, the border of the 2 regions was exposed to intensive irradiation for a prolonged period. Although medullary hematopoiesis was severely affected over a long period of exposure, only a few cases of leukemia were encountered. The development of osteogenic sarcomas in young W/Fu rats irradiated over the head region with 800 R of x rays is also reported. All tumors were located within the irradiated area, but the incidence was low and the latent period >400 days. (BBB)

40933 EFFECTS OF IRRADIATION ON THE THYROID GLAND. Umisa, Hiroyuki (Hiroshima Univ.). Acta Pathol. Jap., 17: 345-7(Aug. 1967).

A morphologic study was made to determine the basic radiation damage to the thyroid by ^{131}I internal irradiation and by x-ray external irradiation. The changes in the pituitary gland which are closely related to thyroid disorders were also examined and a comparative review was made of human cases treated with radiation. Two-month-old mice of the ddN strain received various amounts (1, 3, 5 μCi/g) of ^{131}I administered intravenously in a single or 10 divided doses. A single local x irradiation of the thyroid was made with 750 R. Biopsied and necropsied material from cases treated with ^{131}I or x irradiation and of atomic bomb survivors were studied. In mice, acute effects of ^{131}I irradiation on the thyroid were cytoplasmic vacuolation, nuclear pyknosis, cellular necrosis, breakdown of follicles, edema of the stroma, and fibrinoid necrosis of small blood vessels. The chronic radiation effects with ^{131}I were extensive fibrosis and appearance of follicles with atypical epithelial cells (Askanazy cells) in the thyroid. However, development of tumors from such cells could not be observed. Pituitary tumors invariably developed in the radiothyroidectomized mice after large doses of ^{131}I. A series of changes from the transformation of cells to thyroidectomy cells and formation of microadenomata composed of such cells to the development of gross adenomata is described. This may be attributable to the disruption of homeostasis from the decrease in thyroid hormone secretion. (BBB)

40934 DEVELOPMENTAL ABNORMALITIES DUE TO EXTERNAL IONIZING RADIATIONS: EXPERIMENTAL OBSERVATIONS. Murakami, Ujihiro (Nagoya Univ., Japan). Acta Pathol. Jap., 17: 351-3(Aug. 1967).

Relations between irradiation at various embryonic stages and the malformations manifested were studied in mice of the ddN and CF1 strains exposed to whole-body x radiation on the 7th, 8th, 9th, 10th, 11th, and 12th day of pregnancy. Progenies were examined on the 18th day. Gross malformations manifested were as follows: In CF1 strain mice, 200 R caused many brain hernias. Incidence of arrhinencephalia showed a peak in both strains with 8th day treatment. In the ddN strain, hydrocephalus and microcephalus were seen. Malformations of the tail also peaked in both strains in the 8th-day group. Incidence of cleft palate was high and malformation of the paw, such as micromelia, showed a peak in those treated on the 10th day. In mice irradiated on the 11th day, malformations of the eye, hydrocephalus, and cleft palate presented another peak in the ddN strain as well as the incidence of ectrodactylism and tail anomalies in both groups. Some malformations, such as hydrocephalus and those of the eye, presented biphasic elevations of incidence in the ddN strain, while in the CF1 strain the incidence of malformations of the eye had only one peak. Examination of the 11th-day embryos 2, 6, 12, 18, and 24 hr after irradiation revealed that development of the abnormalities and repair proceeded more rapidly in the CF1 than in the ddN strain. The first peak of incidence represents the indirect effects of x rays upon the organ induction system, ancestral cells of the prospective organs, and primordii just prior to their formation. The second peak represented the direct effect upon the primordium itself. (BBB)

40935 ACUTE RADIATION DAMAGE TO THE DIGESTIVE TRACT: A COMPARISON OF EFFECTS BETWEEN FAST NEUTRON AND X RAYS. Hirose, Fumio (Hiroshima Univ.). Acta Pathol. Jap., 17: 324-7(Aug. 1967).

Six-week-old CF_1 strain female mice were exposed to whole-body irradiation of 640 rad from 14.1-MeV neutrons or 1150 rad of x rays, a dose 1.8 times as large as the dose of 14.1-Mev neutrons. Some mice were given an intraperitoneal injection of 0.5 μCi/g of ^{3}H-thymidine 1 hr prior to irradiation or 1 hr before they were sacrificed, and autoradiographs of the duodenum were prepared. There was no marked difference in the magnitude of damage to the duodenal mucosa between the animals exposed to fast neutrons and those exposed to x rays. Even in animals exposed to x rays, denudation of the villi due to desquamation of the villar epithelium was observed on the third day after irradiation. Atrophy of the crypt was most pronounced 24 hr after irradiation, but recovery began 48 hr after irradiation. Atrophy of the villi became evident 12 hr after irradiation when ^{3}H-labeled cells began to migrate to villi and at 72 hr atrophy was most marked. Almost half of the ^{3}H-labeled cells migrated to the villi 18 hr following irradiation and migration of all the cells was completed 24 hr following irradiation. The time required for labeled cells of the crypt to reach the tip of the villi was slightly shorter in the x-irradiated animals than in the fast-neutron-irradiated animals. The degree of subsequent recovery in mitotic ability was less in neutron-irradiated animals, but the changes in the nucleus were more severe. It was concluded that fast neutrons in comparison with x rays have a marked inhibitory effect on mitotic ability and that this may be attributable to the severe damage to the nucleus, especially to the chromatin attached to the nuclear membrane and nucleolus. (BBB)

40936 PATHOLOGICAL STUDIES ON RADIATION PNEUMONITIS. Kojima, Kuniji; Tachikawa, Shinzo (Niigata Univ., Japan). Acta Pathol. Jap., 17: 330-41(Aug. 1967).

In a previous report of autopsy findings in radiation pneumonitis it was concluded that it was allergic in its pathogenesis. To elucidate the mechanism, experimental radiation pneumonitis was produced in rats. The results of pathological findings in both humans and animals are presented and discussed. From the histological findings at autopsy, radiation pneumonitis was classified into 3 types: alveolar exudative type, interstitial type, and mixed type. At an early stage these 3 types of lesions were related to the degree of vascular impairment, since the alveolar exudative type appeared in cases with severe vascular impairment and the interstitial type in mild lesions. An allergic mechanism appeared to be involved in the onset and the progression of radiation pneumonitis, especially in the alveolar exudative type. The pulmonary fibrosis in radiation pneumonitis is of progressive nature. Histologic features of the experimental radiation pneumonitis produced in rats were remarkably similar to those of the alveolar exudative type in humans. In both animals and humans the onset of pulmonary fibrosis was not associated with atelectasis or infection. A schematic diagram for a possible mechanism of the development of radiation pneumonitis was presented to summarize the concept discussed. (BBB)

40937 EARLY RADIATION PNEUMONITIS. A PHYSIOLOGICAL AND ANATOMICAL STUDY. Wolfe, Steven F.; Benfield, John R.; Crummy, Andrew B.; Briggs, Russell C.; Cree, Edna M. (Veterans Administration Hospital, Madison, Wis.). Ann. Thorac. Surg., 4: 399-411(Nov. 1967).

Early radiation pneumonitis in preoperative and adjunctive cancer therapy was studied in 3 groups of 12 dogs that received fractionated unilateral right thoracic irradiation. The total dose given was 2000, 4000, and 6000 R, respectively. Differential bronchospirometry and diffusion measurements were performed before irradiation, upon completion of therapy, and at 2-week intervals during the ensuing 6 weeks. Bronchial arteriograms, lung scans, and chest x-rays were made simultaneously. Skin changes and representative lung biopsies 6 weeks following the end of therapy were consistent with an irradiation reaction. Differential bronchospirometry and diffusion determinations showed no difference between the irradiated and the contralateral control lung during the period of observation. Lung scans indicated no changes in relative vascular perfusion, and bronchial arteriograms remained unchanged from preirradiation films. Fractionated unilateral thoracic irradiation up to 6000 R produced no significant adverse effects during the first 6 weeks following the end of therapy. (BBB)

40938 EFFECT OF LASER RADIATION ON TEETH AND SOFT TISSUES OF THE ORAL CAVITY. Rybakov, A. I.; Fokin, I. A.; Panikarovskii, V. V.; Kabilov, N. M.; Gutmakher, Yu. A. (Central Scientific Research Inst. Stomatology, Moscow). Stomatologiya, No. 5, 43-6(1967). (In Russian).

Low-power laser radiation (20 joules) in 1 to 20 impulses was focused on extracted human teeth and soft tissues of the oral cavity of Wistar rats. The laser rays formed a conical canal through the enamel and dentine of the teeth. The structure of the tooth around the canal remained unchanged except for a narrow band along the margin of the canal wall. There was no relation between the number of impulses and the depth of penetration of the laser beam into the teeth. But there was a relation between the number of impulses and degree of injury to the soft tissues of the mouse oral cavity. The changes ranged from superficial lesions of the mucosal epithelium to a defect extending into the muscular layer. The bottom and margins of the defect consisted of a zone of structureless necrotic tissue. (JPRS)

40939 BRAIN STEM EVOKED RESPONSES ASSOCIATED WITH LOW-INTENSITY PULSED UHF ENERGY. Frey, Allan H. (Inst. for Research, State College, Pa.). J. Appl. Physiol., 23: 984-8(Dec. 1967).

Evoked potentials in the brain stem of cats were induced by irradiation with pulse-modulated uhf energy. The threshold power density necessary to evoke the potentials was 30 $\mu W/cm^2$ average and 60 mW/cm^2 peak. The results indicated that the potentials were neural rather than an artifact of the situation. Using an echosorb shield to cover the entire cat, head, or body, it was found that the head had to be exposed to the uhf energy in order to have an effect occur. Within the carrier-frequency range used (1.2 to 1.525 Gc), there appeared to be a reduction of effect at the highest frequency. Variation in power density had a distinct effect on the evoked potential. Polarization of the energy, whether perpendicular or parallel to the spine, did not have much effect. As pulse-repetition frequency (PRF) was changed, the evoked potential did not change significantly until the PRF was greater than 50 pulses/sec. When greater than this, there was often an overlap of activity evoked by the series of stimuli. In general, an electrode placed in the rostral brain stem did not yield evoked activity as diffuse and persistent as an electrode placed in the caudal portion of the reticular formation. (BBB)

40940 GENERATION OF ELASTIC WAVES IN THE EYE IRRADIATED BY THE LASER BEAM. Amar, L. (Centre National de la Recherche Scientifique, Paris). Bibl. Ophthalmol., 5: 414-16(1967). (In French).

The fundamental modifications produced by a laser beam during its passage through the eye were studied in relation to therapy for detached retina. It was observed that retinal coagulation occurred at 40°C; this demonstrated that thermal processes alone were not solely responsible. The other major observation concerned the appearance of bubbles in the vitreous humor that were interpreted as a form of vaporization from the interstitial liquid of the choriod. In the experiments passing of the laser beam through isolated vitreous produced the same bubbles and showed that they were not formed in the choriod. Ultrasound waves were detected and the bubbles were determined to be the result of cavitation. Gas dissolved in the vitreous was vaporized at the time of instantaneous decompression that accompanied the elastic wave. The sound waves were only generated when the laser beam passed through the pupil, not through any other part of the eye. Ultrasound waves were generated at ~40,000 cps and traversed brain matter and cerebrospinal fluid at a velocity of 1500 m/sec. It was concluded that the elastic waves had a greater biological effect than the laser beam itself. (BBB)

40941 THE EFFECT OF DOSE RATE ON THE ACUTE RADIATION SYNDROME IN THE BEAGLE, WITH SPECIAL CONSIDERATION FOR THE HEMATOPOIETIC SYSTEM. Woodward, Kent Thomas. Rochester, N. Y., Univ. of Rochester, 1966. 228p.

Thesis.

Experimental studies were undertaken to determine the response of beagles exposed dorso-ventrally to graded doses of 1000 kVp x rays administered between 1 and 12.2 R per min. Ten beagles in each of three groups were exposed to 450, 600, and 750 R at an exposure rate of 1 R per min. The LD_{50} value was estimated to be 524 rads. Similarly, 10 beagles in each of two groups were exposed to 400 and 600 R at exposure rates of 11.4 and 12.2 R per min and the LD_{50} value was estimated to be 386 rads. The estimated relative potency of the higher intensity exposure was 1.34. The time of onset of the acute radiation syndrome, incidence and severity of hematopoietic responses, and the length of survival were dependent on the total dose delivered and the exposure intensity. For comparable doses the onset of illness was accelerated and the signs more pronounced at the higher exposure intensity. After whole-body exposure death ensued earlier after higher intensity irradiation. (Disser. Abstr.) (TSS)

40942 LIFE IN ENVIRONS OF CONTINUING HIGHER LEVELS OF ADDED RADIANT ENERGY FROM PUBERTY TO DEATH AS EXPRESSED BY MICE. Gowen, John W.; Stadler, Janice (Colorado State Univ., Fort Collins). Environ. Res., 1: 145-70(Oct. 1967).

The effects on 2338 mice of living in an atmosphere of continuous high-energy radiation at 9 different doses throughout life, up to 1300 days from birth were studied. A factorial arrangement of 8 inbred strains of mice, and ^{60}Co irradiation dose rates ranging from 0 to those lethal to the mice in an average of 42 days was set up. The mice were started on continuous irradiation at 46 days from birth, beginning at puberty, and were irradiated an average of 22 hr/day. A total of 1702 mice of comparable inbred strains received only spontaneous irradiation. Life time survival in these environments closely depended on the dose. Longevities of the male and female mice decreased with increased radiation in the environment. The males lived slightly longer than the females for each dose level. Life table data, l_x, e^0_x, and q_x, were presented for each 50 days the mice lived in each environment. The mice receiving only spontaneous irradiation demonstrated that part but not all of this decline was attributable to aging processes in the mice. Analyses of the frequencies of deaths for the 9 different environments showed the relations were on a logarithmic scale. The coefficients of variation of the death curves for the different environments remained nearly constant at about 40. Beta-1 and Beta-2 constants showed changes in the skewness or kurtoses of the death frequencies with life in environments of above normal doses. With 2.36 or 3.48 R/hr added, irradiation disruption of normal life mechanisms became severe, skewnesses of the death frequencies increased 100-fold, and frequency distributions changed from near normal to highly leptokurtic. (BBB)

40943 RADIOAUTOGRAPHIC STUDIES IN NEOPLASIA OF THE UTERINE CERVIX. Iliya, Fawzi A.; Azar, Henry A. (Columbia Univ., New York). Amer. J. Obstet. Gynecol., 99: 515-21(Oct. 15, 1967).

In vitro uptake of tritium-labeled thymidine by cervical biopsy fragments was studied to evaluate the rate of DNA synthesis in cervical dysplasia, carcinoma in situ, and invasive carcinoma. The effect of radiotherapy on the uptake of tritium-labeled thymidine by cervical carcinoma was likewise investigated. Analysis of radioautographs revealed high uptake of tritium-labeled thymidine in dysplasia as well as in carcinoma in situ, whereas thymidine uptake was limited to less than 5% of basal and parabasal cells of normal epithelia. The thymidine uptake in invasive carcinoma did not reach the high level, of 75% or above, observed in severe dysplasia or carcinoma in situ. Irradiation of squamous cell carcinoma was followed by a marked decrease in uptake of tritium-labeled thymidine. Radiotherapy consisted of both intracavitary Ra implantation and external x-ray therapy. No preirradiation radioautographic studies were done; however, all postirradiation radioautographs of samples of invasive squamous cell carcinoma of the cervix showed no labeling or labeling of less than 5% of tumor cells. Most unlabeled tumor cells appeared viable and markedly anaplastic by conventional microscopy. Likewise, irradiated carcinosarcoma showed only occasional labeled large mesenchymal cells, whereas there was considerable labeling of dysplastic epithelial cells in the overlying squamous epithelium. Irradiated mucinous carcinomas showed slight to moderate labeling of tumor cells in the range anticipated in nonirradiated carcinoma. (BBB)

40944 RADIOTOKSINY, IKH PRIRODA I ROL' V BIOLOGICHESKOM DEYSTVII RADIATSII VYSOKOY ENERGII. (Radiation Toxins: Their Nature and Role in the Biological Effect of High-Energy Radiation). Kuzin, A. M. (ed.). Moscow, Atomizdat, 1966. 292p.

Theoretical and experimental data on the formation of toxins in irradiated organisms, as compiled from the materials of the First All-Union Conference of Radiobiologists in 1965 dealing with the nature and role of radiotoxins in the biological effects of ionizing radiation are presented. The quantitative relations for the formation of toxins, their chemical nature, and a wide spectrum of their radiomimetic properties moved the problem of toxins to the center of attention in the study of initial and activation mechanisms of the biological effects of ionizing radiation. The nature and properties of secondary radiotoxins that are formed with radiation sickness are investigated from the point of view of pathogenesis and radiation-disease therapy. The book is intended for scientific personnel working in radiobiology, graduate students, students in appropriate advanced courses, and for a variety of surgeon-radiologists, and specialists concerned with problems of the use of atomic energy in agriculture. (ATD)

40945 KINETICS OF RADIOBIOLOGICAL EFFECTS. Kondo, Sohei (Osaka Univ). Tanpakushitsu Kakusan Koso, 11: 585-7 (June 1966). (In Japanese).

Molecular kinetics in radiobiology is discussed. In the biological action of ionizing radiation, the effect of excited molecules is almost negligible in comparison with the effect of ions induced by radiation. According to the target theory, the number of ionized forms produced in the target by irradiation can be calculated. In microorganisms, a lethal effect may occur with a 10^{-6} mole ionization concentration, a much lower lethal concentration than with ordinary chemical substances. Higher organisms show different biological reactions to radiation, but some correlation between RBE (relative biological effectiveness) and LET (linear energy transfer) has been observed. Some molecular genetics phenomena such as radioresistance, induction of mutations, and repair mechanisms can be explained by the chemical target theory. The lethal effect of uv radiation in microorganisms is considered to result from thymine dimer formation in the DNA molecule. In Escherichia coli, a photoreactivating enzyme reacts with the thymine dimer and leaves it to the monomer form under visible-light irradiation. There may be other repair mechanisms for removal of thymine dimers from the DNA molecule. The chemical kinetics of the radiosensitivity and photoreactivation in E. coli is discussed. The lethal sensitivity of some carcinogenic substances, such as 4-nitroquinone-1-oxide, on various bacteria is considered to be similar to the effect of uv irradiation. (BBB)

40946 RADIOLOGIST AND THE RELIEF OF PAIN. Griem, Melvin L. (Univ. of Chicago). Med. Clin. N. Amer., 52: 203-6 (Jan. 1968).

In the treatment of benign diseases with radiation therapy, various complications may be encountered. There may be acute skin reactions or injury to sensitive organs such as the kidney, lung, and lens, late effects with tissue fibrosis and endarteritis, with resultant ulceration of the skin. Bone necrosis and changes in the central nervous system may also be associated with high doses of irradiation. Carcinogenesis is most often seen in the skin, thyroid gland, and bone. Induction of leukemia may occur following treatment of benign diseases. There may be deep-seated injury to proliferating centers with injury to epiphyses in young children. Irradiation of the gonads may result in genetic injury. In patients irradiated for rheumatoid spondylitis an increased incidence of leukemia and chromosome abnormalities in circulating blood cells years after therapy has been noted. There are no valid indications for the treatment of tonsillitis, mastoiditis, thyroiditis, myositis, and similar inflammatory conditions by irradiation. (BBB)

40947 MORTALITY FROM CONTINUOUS X IRRADIATION IN MICE: III. CHANGES OF ORGAN WEIGHTS. Ikeda, Yoshiharu (Hiroshima Univ.). Hiroshima Daigaku Igaku Zasshi, 15: 431-67(May-June 1967). (In Japanese).

The effects of continuous 200-kV x irradiation on the wet and dry weights of various organs were studied. In ddN strain male mice with 20 to 25 g body weight, were continuously irradiated at dose rates of 100 to 10,000 R/day for up to 22 days at the lower doses. The animals were killed at 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 15, 18, 20, and 22 days after irradiation and the wet and dry weights of various organs, i.e., spleen, pancreas, small and large intestines, stomach, liver, kidneys, lungs, heart, thyroid, testes, and brain were measured. In general, some correlations were observed between the irradiation dose and the decrease in organ weight, either wet or dry. The spleen showed a rapid decrease in weight from one day after irradiation that was reflected in the destruction of cell constituents. The decrease of food intake and secondary metabolic disturbances after irradiation may have been related to the low organ weight. The digestive tract also showed marked weight loss after irradiation. The 1000 to 10,000 R/day irradiated group showed higher weight loss than the 100 to 200 R/day irradiated groups. A slight decrease in weight of the pancreas and kidneys was observed. The weight change in the liver was similar to that of the digestive tract. The secondary metabolic disturbances and catabolism of tissue after irradiation may be the cause of the decreased organ weight. There was no weight change in lungs, heart, and thyroid after irradiation. A significant decrease in the weight of testes was observed after irradiation. (BBB)

40948 THE EFFECT OF GAMMA IRRADIATION ON THE DAILY EOSINOPHIL RHYTHM IN THE PERIPHERAL BLOOD OF MICE. Shapiro, F. B.; Kirilchenko, A. M. Probl. Endokrinol. Gormonoter., 11: 97-101(Mar.-Apr. 1965). (In Russian).

A study was made of the effect produced by single whole-body ^{60}Co γ-irradiation dose of 500 R on the 24 hr eosinophil rhythm in the peripheral blood of mice (BALB/C strain). It was found that irradiation caused changes in the 24 hr eosinophil rhythm, such that during the day time there was no rise in the eosinophil count, characteristic of control animals. No complete equalization occurred in the 24 hr eosinophil rhythm after placing the irradiated animals under conditions of all-day illumination or all-day darkness. After restoration of the normal illumination conditions, the 24 hr curve of the eosinophil count was restored in the irradiated animal to the level which developed in them as a result of the action of ionizing radiation. The 24 hr eosinophil rhythm disturbances following irradiation were considered to be a sequence of hypophysis-adrenal cortex system stimulation. (BBB)

40949 THE EFFECT OF LOCAL HYPOXIA ON RADIOSENSITIVITY OF TISSUE. Gordienko, G. P.; Bernshtein, V. A. Tr. Kaz. Nauch.-Issled. Inst. Onkol. Radiol., 1: 361-5(1965). (In Russian).

Two experiments included 51 rats (wt 200 to 350 g), 20 in the first and 31 in the second experiment. In all animals, deprived of food for 12 hr, a rubber tourniquet was applied to the right thigh to induce a local hypoxia. One hr later (first experiment, 10 rats in controls), the skin temperature below the tourniquet coincided with the room temperature, while the opposite limb registered a temperature higher by 10 to 12°C, indicating that a high degree of hypoxia existed in tissues of the occluded limb. After a 90 min retention of the tourniquet, the affected part of the leg was exposed to 50-kV x radiation (4000 R total), at a 166 R/min dose rate, whereupon the tourniquet (applied no longer than 120 min) was removed. Each rat received this treatment twice with a three-day interval between treatments. The rats were observed for ~45 days. The examination included: variations in weight, physical activity, state of fur, hyperemia of irradiated limb, alopecia, dry and moist epidermitis, radiation ulcers, and hematology. All control animals were irradiated without application of the tourniquet. The second experiment included the application of tourniquet to the right hind leg and 10 min later x irradiation (10,000 R, at 120 R/min). Then the

tourniquet was removed after a 10 min period (total limb occlusion 140 min). Following each irradiation, clinical examinations were carried out as described above and included both legs. Of 31 rats in this experiment, ten died after irradiation. Comparison of the results with those of the first experiment showed wide variations, although the animals irradiated with the tourniquet applied underwent a milder course of the radiation sickness as seen in local reactions, i.e., reduced incidence rate and smaller radiation ulcers. The blood picture was almost the same in both groups of animals. In the second experiment, hyperemia and moist epidermitis developed in the tourniquet-occluded legs but fewer moist epidermitis areas developed into ulcers (6 per 21) than in the control limb (13 per 21). Subsequently, eight of the control limbs became gangrenous. The results of both experiments indicated that local hypoxia lowered the radiosensitivity of limb tissues. (BBB)

40950 BLASTOMERE DIFFERENTIATION OF SOMA AND GERMINAL TRACT IN PARASCARIS EQUORUM. II. STUDIES WITH UV IRRADIATION AND CENTRIFUGATION. **Moritz, Karl B. (Univ., Munich). Arch. Entwicklungsmech. Organ., 159: 203-66 (July 18, 1967). (In German).**

After a brief introduction and a description of materials and methods, the potentialities of differentiation of Parascaris equorum blastomeres by means of their reactivity to uv irradiation, wavelength 250 to 320 nm., are analyzed. This includes sensitivity to total uv irradiation as measured by mortality during early cleavage, by delayed cleavage after uv irradiation of the polar caps within the blastomere, and by speed of cleavage. Chromatin diminution induced by uv irradiation was studied as a function of dose and stage of mitosis, cell region irradiated, position of the spindle, time of induction of chromatin diminution, and cytology. Relations between cell differentiation, and cytoplasmic and nuclear properties are described. The author discusses polarity and differentiation of the nucleus, interprets the causes of the sensitivity of the ova to uv irradiation, cytoplasmic factors in nuclear differentiation, structure of aggregated chromosomes, conditions and significance of chromosome diminution, and compares the diminution with the elimination of germinal tract chromatin. (BBB)

40951 EXPERIMENTAL PREVENTION OF NERVE HOMOGRAFT REJCTION BY USE OF IMMUNOSUPPRESSIVE DRUGS. **Marmor, Leonard; Miner, Robert; Foster, John (Univ. of California, Los Angeles). J. Neurosurg., 27: 415-18(Nov. 1967).**

An experiment was performed to study the effect of an immunosuppressive drug (Imuran) on homotransplantation of peripheral nerves in rats and to compare it with irradiation of the graft and with a combination of both methods. The rats were administered the drug orally (200 mg/Kg of diet) for five days, and a 1 cm segment of homogenous sciatic nerve was then implanted subcutaneously in the anterior thigh of half of the rats. In the other half an irradiated homograft was implanted subcutaneously. At two weeks there was no evidence of destruction of the irradiated graft, and the nonirradiated graft was also intact with little evidence of inflammation. The nonirradiated implant at five weeks revealed little inflammatory response although some axis cylinders were disrupted. The non-irradiated implant at five weeks revealed little evidence of rejection. Results indicated that Imuran at nontoxic dosages has a significant immunosuppressive action on the rejection of nonirradiated homografts. In a second experiment Imuran was used to try to prevent rejection of nerve heterografts (upper and lower facial nerves) in the rat. All of the control nerves recovered function. The rats treated immediately with Imuran took longer to recover than those treated 12 days after surgery with Imuran. None of the heterografts recovered function, but early Imuran treatment definitely protected the grafts from immune inflammatory response while the delayed Imuran treatment group showed almost complete destruction of the graft. Experience in patients with irradiated homografts alone also showed that regeneration does occur, but not consistently. Regeneration through a graft unprotected by irradiation or immunosuppressive drugs is prevented by an inflammatory response and scar formation in the axis cylinders. Imuran can prevent such rejection phenomena in nerve homografts. (BBB)

Radiation Effects on Plants

Refer also to abstracts 40519, 40542, 40618, 40619, 40621, 40624, 40630, 40635, 40639, 40647, 40649, 40766, 40772, 40826, 40874, 40944, 40945, 40985, 40986, and 42576.

40952 (ORO-657, pp 93-120) PLANT STUDIES. **(UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).**

Data are presented on the use of marker traits to evaluate the effects of seed moisture content on mutation frequency and survival of hybrid cotton seeds exposed to fission neutron or gamma radiation. Results indicate that γ-irradiated seeds, but not fission neutron-irradiated seeds were moisture dependent in regards to both mutation frequency and survival. Results are also presented on the effects of gamma radiation on incidence of mutations for quantitative traits (size, yield, and early maturity) in cotton, soybean, wheat, oats, and barley. A comparison was also made in the small grain seeds of the effects of γ rays, fission neutrons, and EMS on mutagenesis. Seeds receiving 10,000 rads of γ-rays or 1,000 rads of fission neutrons failed to produce surviving plants; EMS showed no effects at doses between 0.001 and 0.100 M. Research on the effects of γ rays on translocation-type exchanges of genetic material in interspecific hydrids of cotton was started, but no conclusive results are reported to date. Progress reported in other plant studies includes: genetic control and environmental modification of seed radiosensitivity; status report on the cooperative irradiation program; success of the summer institute in radiobiology; effects of ^{32}P on Coleus and Tradescantia; effects of seed moisture content on γ-radiosensitivity of chlorogenic acid production in sunflower seeds; and analysis of anthocyanin pigments in fast neutron-radioinduced mutants of Coleus and poinsettia. Through the use of thin-layer chromatography, four pigments from the mutants have been identified to date. (E.R.B.)

40953 (UH-235-P-6-5) STUDIES ON THE EFFECT OF IONIZING RADIATIONS ON THE PROCESSES OF CELLULAR PROLIFERATION, MEGASPOROGENESIS, AND EMBRYO-SAC DEVELOPMENT. **Annual Progress Report, September 1, 1967-June 1, 1968. Sagawa, Yoneo (Hawaii Univ., Honolulu). Contract AT(04-3)-235. 10p. Dep. CFSTI.**

Histochemical studies on the distribution of nucleic acids, total proteins, and insoluble polysaccharides in the megaspore, embryo sac, and protocorm of Vanda spp. were made. Radiosensitivity of megagametogenesis and megagametophyte formation was analyzed by treating fruits set on Dendrobium phalaenopsis type orchids with 5000 R at weekly intervals after pollination. Patterns of necrosis were observed and changes were noted between the fifth and sixth weeks. Radiosensitivity of orchid embryos was analyzed by irradiating fruits with a single acute dose of 7500 R and 10,000 R of x rays at weekly intervals from nine through 20 weeks after pollination. Differential sensitivity of certain cells and regions of proembryos and young embryos was observed. Embryos were cultured on agar media to follow viability and production of anomalies in seedlings. Irradiated embryos progressed to the yellow-green protocorm stage only, while controls were green with leaves. (H.L.W.)

40954 EFFECT OF HEAVY WATER ON THE GERMINATION OF A NUMBER OF SPECIES OF SEEDS. **Blake, M. I. (Univ. of Illinois, Chicago); Crane, F. A.; Uphaus, R. A.; Katz, J. J. Planta, 78: 35-8(1968).**

The effect of deuteration on the germination rate of seeds of 16 plant species was studied prior to the cultivation of the plants in various concentrations of D_2O. The D_2O levels studied were 0, 25, 50, 80, 90, and 100%. For seven of the species examined, germination was severely inhibited in high concentrations of D_2O. Rye, peas, corn, and fescue germinated well at all levels of D_2O. Flax, lettuce, beans, and wheat germinated well in 90% D_2O, but poorly in pure D_2O. The time required for half the seeds to germinate is shown. Plant species that were less inhibited by high D_2O levels also showed smaller changes in germination rate. Generally, the half-times of germination in pure D_2O were about double those of the controls in H_2O. However, flax and lettuce, which had very short half-times in H_2O, showed a 7-fold and 13-fold increase in half-times, respectively. Convolvulus (morning glory) and squash, while severely inhibited in germination at high levels of D_2O, showed less of an effect in half-time of germination. There appears to be a simple relation between size of the seed and germination capacity in high deuterium concentrations. Larger seeds may be more successful in germinating because of greater hydrogen-containing food reserves. (BBB)

40955 RADIATION-INDUCED DAMAGE IN VEGETATIVE TISSUES OF PINUS RIGIDA MILL. **Mergen, Franscois (Yale Univ., New Haven); Thielges, Bart A. Contract AT(30-1)-2755. Cytologia (Tokyo), 32: 248-54(1967). (BNL-10268).**

Epicormic shoots formed after irradiation for P. rigida trees growing at various distances from the ^{137}Cs source in the Ecology Forest at the Brookhaven National Laboratory were examined. Higher exposures caused all types of nuclear damage in mitotic cells of the epicormic sprouts. Chromosome aberrations were present at all exposure levels and increased greatly at levels of 7 R/day and higher. There was also a significant increase in the number of multiple bridges with increased exposure. Increased dia of the resin canals in stem cross-sections provided further evidence of radiation sensitivity at higher exposures. The average dia of epithelial cells was also greater in the irradiated

shoot. The increase in number and size of ducts at the tip of irradiated shoot may be a result of increased damage in an activity growing region. The results indicate that the irradiated sprout developed under conditions of stress imposed on the tree by direct or indirect radiation damage, and confirm the high radiosensitivity during the mitotic process. Considerable nuclear damage was present even at lower levels of exposure. Occurrence of stem sprouts on trees growing at higher exposures that seemed to have been killed by radiation indicate the resistance of the species. (BBB)

40956 AFTER-EFFECTS OF COTTON SEED TREATMENT WITH γ RAYS. Ibragimov, Sh. I.; Popova, P. Ya. (Inst. of Experimental Plant Biology, Tashkent). Khlopkovodstvo, 15: 47-8 (Nov. 1965). (In Russian).

Experiments performed from 1960 to 1964 on the treatment of cotton seeds with ^{60}Co γ rays indicated that the most-growth-stimulatory-total-doses were from 500 to 2000 rad. The average 3-yr increase of the productivity of cotton resulting from a total 500-rad/yr dose was 1.8 centner/hectare. In a more recent experiment, total 1000 to 2000 rad/yr doses substantially increased the productivity of cotton plants by 2.4 to 3.5 centner/hectare and most of the radioinduced advantages were retained in the next generation with respect to the growth of plants and their productivity. It was found that in the treatment of cotton seeds with γ rays the threshold value between stimulatory and inhibitory doses was 3000 rad/yr. Higher radiation doses used on cotton seeds not only adversely affected the normal development of plants but also their productivity. Cotton seeds irradiated at γ doses of 10,000 to 25,000 rad produced stunted plants and the productivity of cotton fiber was only ⅓ that of the controls. (BBB)

40957 GERMINATION BEHAVIOR OF SALSOLA AS INFLUENCED BY TEMPERATURE, MOISTURE, DEPTH OF PLANTING, AND GAMMA IRRADIATION. Wallace, A.; Rhods, W. A.; Frolich, E. F. (Univ. of California, Los Angeles). Contract AT(04-1)-GEN-12. Agron. J., 60: 76-8 (Jan.-Feb. 1968). (UCLA-12-652).

Salsola kali, a troublesome weed, invaded the areas used for above-ground thermonuclear testing at the Nevada Test Site and persisted for a few years thereafter before disappearing from those specific sites. Its germination behavior was studied to clarify its peculiar ecological behavior. Germination and growth of ^{60}Co γ-irradiated seed were examined. Germination was slightly impaired by exposures of seed to doses up to 500,000 R. At 1,000,000 R no seed germinated. Seedlings slowly died when irradiated at ~100,000 R. Cell division of germinating seeds was impaired at levels of irradiation much above 50,000 R, and elongation of root and shoot was almost equal above 100,000 R to about 400,000 R. Evidently no new cell division occurs at irradiation levels above about 100,000 R. Apparent seedling growth from such plants would then be from cell elongation only. The embryo, therefore, probably contains the complete seedling with cells all divided and differentiated. Seedlings emerged when the seeds had been covered with 7.5 cm of soil, but not at a depth of 13 cm. The amount of elongation of the seedlings which did not emerge approximated that of seedlings irradiated with ^{60}Co at levels high enough to stop all new cell division. (BBB)

40958 GROWTH AND RNA NUCLEOTIDE COMPOSITION IN DATURA TISSUE AFTER X IRRADIATION. Rohde, Hans-Georg; Brucker, Wolfgang (Ernst-Moritz-Arndt-Univ., Griefswald, Ger.). Z. Pflanzenphysiol., 58: 327-30 (Feb. 1968). (In German).

The influence of x irradiation (200 KV, 2 KR) on the fresh weight increase of Datura innoxa crown gall tumor in tissue cultures was studied for 33 days. At the end of this period the irradiated tissues weighed only 31% of the untreated controls. The nucleotide composition of the bulk RNA was determined using alkaline hydrolysis and Dowex 1 column chromatography. The cytidine-2′,3′-phosphate content increased during growth, whereas the guanosine-2′,3′-phosphate content decreased. There seemed to be a small decrease in the uridine-2′,3′-phosphate content. The adenosine-2′,3′-phosphate content remained unchanged. It is suggested that mainly the nucleotide composition of ribosomal RNA changes during growth. The base composition of RNA from irradiated tissues was the same as that of the controls. (BBB)

40959 EFFECT OF MASSIVE X-IRRADIATION ON PROTEINS AND PROTEIN SYNTHESIS IN PEANUT COTYLEDONS. van Huystee, R. B. (Univ. of Western Ontario, London). Can. J. Biochem., 46: 685-9 (July 1968).

Peanut seeds were irradiated with 500 kR of x rays and stored for 6 weeks. The cotyledons from 3-day-old seedlings were harvested, and incubated with leucine-^{14}C. The water-soluble protein content of those cotyledons was half to one-third that of the non-irradiated cotyledons. Protein biosynthesis in the irradiated cotyledons was equally reduced to one-third or less of control. Separation of the extracted proteins by acrylamide-gel electrophoresis suggested that there may be a larger amount of small-molecular proteins in the irradiated system. De novo biosynthesis after irradiation was restricted in all protein fractions. Enzyme activity was also severely restricted. No particular radiation-resistant isoenzyme of peroxidase could be detected. (auth) (UK)

40960 IRRADIATION OF DRY SEEDS OF VICIA FABA WITH 3 GeV PHOTONS. Kuenkel, Hans A.; Staehler, Fritz; Zywietz, Friedrich (Univ., Hamburg). Strahlentherapie, 134: 426-33 (Nov. 1967). (In German).

Investigations were carried out on dry seeds of Vicia faba irradiated with 3-GeV-photons at the Hamburg Elekton-Synchrotron (Desy). Dosimetry was done by means of the ferro-ferri-reaction. The growth of the shoot and of the primary root, the number of lateral roots as well as the rate of mitoses in the root-tips was found to be less reduced at high energy radiation than after equal doses of 200-keV-x rays. The RBE was calculated to be about 0.8. No significant differences between both kinds of radiations were observed in the radioinduced decrease of dry weight of the seedlings. (auth)

40961 GROWTH AND MORPHOLOGY OF HEALTHY AND TOBACCO MOSAIC VIRUS-INFECTED TOBACCO CELLS IN MICROCULTURE EXPOSED TO ^{60}Co RADIATION. Cruz, Angelita; Hildebrandt, A. C. (Univ. of Wisconsin, Madison). Radiat. Res., 34: 604-15 (1968).

Healthy and tobacco mosaic virus-infected tobacco (Nicotiana tabacum var. Havana 38) cells from suspension cultures, transferred to aseptic microcultures, exposed to gamma irradiation, and observed with phase microscopy showed damages to nuclear and cytoplasmic structures and modifications of normal dynamic activities. Deformation and displacement of cell nucleus, thinning of cytoplasmic strands, and reduction in starch granule size and number followed irradiation. The type and amount of damage and cellular modification were influenced by the radiation dose. Healthy and virus-infected cells exposed to 250,000 R or more showed decreased cyclosis immediately after irradiation. This effect was temporary except for cells exposed to 1×10^6 R. A high cell death rate occurred during the first 2 weeks after irradiation. Cells surviving irradiation treatments showed high starch contents in certain stages. Cells surviving for 4 weeks after irradiation lived for several months. Some irradiated cells survived severe cellular damages. Survival of TMV-infected cells was lower than that of healthy cells after exposure to the same radiation dose. Low radiation doses did not alter division of healthy cells, but 100,000 R or more decreased divisions to 10 to 20%. TMV-infected cell divisions were reduced progressively with increasing radiation doses from 100 to 50,000 R. Some cells resumed normal growth activities and either formed large cells or divided to form cell colonies. (auth)

40962 SOME KINETIC ASPECTS OF RECOVERY OF G_1 AND G_2 CELLS IN STATIONARY-PHASE EXCISED PEA ROOTS. Van't Hof, Jack (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 34: 626-36 (1968). (BNL-11793).

Recovery after exposure to 300 R of γ rays by G_1 and G_2 stationary-phase meristematic cells of excised pea root tips was measured as a function of the duration of an induced post-irradiation stationary phase. The recovery indices measured were the initiation of DNA synthesis by G_1 cells (^{3}H-thymidine incorporation) and the entrance of G_2 cells into mitosis. Results showed that cells in each phase required 24 to 26 hours for full recovery. Recovery rate of G_1 cells was relatively constant throughout the 24-hour period, while that of G_2 cells varied, being higher in the first half and lower during the last half of the recovery period. Recovery of G_1 and G_2 cells exposed to a total of 300 R at a rate of 300 R/min was the same, provided the stationary phase was not continued after γ exposure. (auth)

40963 INHIBITORY EFFECT OF IODOACETAMIDE ON RECOVERY FROM SUB-LETHAL DAMAGE IN CHLAMYDOMONAS REINHARDTI. Hillova, J.; Drasil, V. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 12: 201-8 (1967).

Recovery of x-ray induced sub-lethal damage in synchronized cultures of Chlamydomonas reinhardti, studied by the dose fractionation technique, was accompanied by an increase in D_0 of the recovered cells. The values of D_0 after the acute and fractionated doses (fractionation interval 200 min) were 2550 and 7090 rads, respectively. Iodoacetamide (IOAM) when present during irradiation at the concentration of 1×10^{-4} M sensitized C. reinhardti to x rays. This effect was about three times higher in the recovered cells after the test dose given in the presence of IOAM. The resulting D_0 had the same value (1600 rads) as after the acute dose given in the presence of IOAM. Incubation of irradiated cells with IOAM during the fractionation interval, sufficiently long for complete recovery, caused inhibition of the recovery mechanisms.

The fact that, in normal as well as in recovered cells, IOAM reduced D_0 to the same value, was also considered to be a result of inhibition of the repair mechanisms. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 40524, 40552, 40560, 40566, 40567, 40580, 40582, 40591, 40598, 40622, 40623, 40625, 40628, 40629, 40632, 40636, 40638, 40648, 40650, 40653, 40654, 40782, 40793, 40944, and 40945.

40964 ANALYSIS OF ULTRAVIOLET DOSE EFFECT CURVES OF T7-PHAGE. Ronto, Gyoergyi; Sarkadi, Karoly; Tarjan, Imre (Univ., Budapest. Mathematics Inst., Budapest). Strahlentherapie, 134: 151-7(Sept. 1967). (In German).

The dose effect curves obtained from the plaque-forming ability of T7 phages after uv-irradiation are interpreted. The mathematical model used for analyzing the experimental results was an improvement of the classical target theory in regard to the systems used. Based on the calculations, a probability of 2×10^{-4} for uv-induced reactivation was obtained. The number of hits was, at any rate, larger than 100. The model could be used for analyzing dose effect curves of similar shape. (auth)

40965 THE EFFECT OF CAFFEINE ON THE REPAIR OF ULTRAVIOLET-DAMAGED DNA IN BACTERIA. Shimada, Kazunori; Takagi, Yasuyuki (Kyushu Univ., Fukuoka). Biochim. Biophys. Acta, 145: 763-70(Oct. 16, 1967).

The effect of caffeine on host cell reactivation of ultraviolet-irradiated λ phage and on ultraviolet-induced degradation of bacterial DNA was investigated using an ultraviolet-sensitive and host cell reactivation negative mutant of Escherichia coli in which ultraviolet-induced DNA breakdown takes place. The photoreactivation was rapidly impaired after infection of the mutant with ultraviolet-irradiated λ phage. In the presence of 1.0% caffeine the photoreactivability of the ultraviolet-irradiated phage was almost completely preserved in this strain. Caffeine inhibited ultraviolet-induced DNA breakdown in bacteria. The intracellular state of the ultraviolet-irradiated λ phage DNA was studied using the sucrose density-gradient centrifugation technique, and it was observed that caffeine inhibited the introduction of a first clip in the λ phage DNA pre-exposed to ultraviolet light. It was suggested that caffeine depresses the excision of pyrimidine dimers from ultraviolet-irradiated DNA. (auth)

40966 IMMUNOGENICITY OF IRRADIATED SALMONELLA TYPHIMURIUM CELLS AND ENDOTOXIN. Previte, Joseph J. (Army Natick Labs., Mass.). J. Bacteriol., 95: 2165-70(June 1968).

The effects of high doses of radiation (1, 5, or 20 Mrad) on the toxicity, pyrogenicity, and immunogenicity of Salmonella typhimurium cells and endotoxin were studied. Toxicity decreased progressively after exposure to 1, 5, or 20 Mrad. The lethal effect of 1-Mrad exposed cells was greater than that of heat-, acetone-, or alcohol-killed preparations. An amount of 5 Mrad is about a 50% end point in terms of inactivation of the lethal lipopolysaccharide or cell-associated determinants. The fever response to radiation-killed salmonellae decreased between 1- and 20-Mrad exposure. The immunogenicity of 1-Mrad-treated cells usually exceeded that of nonirradiated preparations in mouse-protection tests. With increasing radiation doses, there was a dramatic decrease in, but not an abolition of, immunogenicity. Preparations exposed to 20 Mrad which were nonlethal afforded significant protection. The results are interpreted as a reflection of a dissociation of the primary and secondary toxic determinants of endotoxin after irradiation. The data indicate the potential value of radiation sterilization as a means of production of Salmonella vaccine. (auth)

40967 EFFECT OF COMBINED ACTION OF IONIZING RADIATION AND FLUORIDE ION ON LETHALITY OF MICROORGANISMS. Namiki, Mitsuo (Inst. of Physical and Chemical Research, Tokyo). J. Radiat. Res., 8: 1-13(Mar. 1967).

Enhancement of radiolethality of Escherichia coli was observed by KF during irradiation. The shape of the survival curve was not altered by KF, and it was only effective at a pH below 6.0 and was not influenced by oxygen or additional SH compound. Pre- or post-irradiation treatment with KF did not exert any changes in viability of cells. The effect of fluoride ions on water radiolysis was investigated, and these results were discussed in relation to other halide ions. (auth)

40968 REPAIR PROCESSES IN HYDROXYLAMINE-INACTIVATED PHAGE. Vizdalova, M. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 12: 227-34(1967).

The possibility of reactivation of the λcb2 phage inactivated by a radiomimetic substance, hydroxylamine, with the aid of enzymatic repair processes (photoreactivation, host-cell reactivation, uv reactivation) and of processes based on genetic recombination (multiplicity reactivation) was studied. It was found that lethal damage of the phage caused by hydroxylamine could be markedly repaired (37.5 per cent) only with the aid of uv reactivation. In host-cell reactivation only 9 per cent of the lethal damage was removed, and no photoreactivation was ascertained, which indicated that hydroxylamine did not cause the formation of thymine dimers in the DNA molecule. A positive result was not accomplished even in multiplicity reactivation, probably as a result of certain damage of the phage inhibiting early processes occurring in the course of infection. (auth)

40969 THE EFFECTS OF 5-FLUOROURACIL POSTTREATMENT ON SENSITIVITY TO ULTRAVIOLET LIGHT IRRADIATION AND THE COURSE OF RIBONUCLEIC ACIDS' SYNTHESIS IN ESCHERICHIA COLI CELLS. Brozmanova, Jela; Stefunkova, Eva; Sedliakova, Milena; Gruenberger, Dezider (Biological Inst., Bratislava. Inst. for Organic Chemistry and Biochemistry, Prague). Biologia (Bratislava), 23: 179-89(1968).

The postirradiation effect of 5-fluorouracil (5-FU) on the syntheses of r-RNA and s-RNA and on sensitivity to uv irradiation by the strain Escherichia coli B/r and Escherichia coli 15 T^- U^- his^- was examined. In the case of E. coli 15, the posttreatment with 5-FU was performed in conditions of starvation for uracil. Under these conditions, a higher inhibition of RNA synthesis in presence of 5-FU was observed by the strain E. coli 15, in comparison with prototrophic strain E. coli B/r. The RNA synthesis after uv irradiation in presence of 5-FU was compared with sensitivity to uv irradiation by the two above mentioned strains. (auth)

40970 THE POSSIBLE PARTICIPATION OF m-RNA IN A REPAIR OF DAMAGED GENETIC INFORMATION. Sedliakova, Milena; Brozmanova, Jela (Biological Inst., Bratislava). Biologia (Bratislava), 23: 190-9(1968).

The effect of temporary removal of energetic source on RNA synthesis by exponentially growing culture of E. coli 15 THU was studied. The synthesis of total RNA was, under these conditions, completely inhibited. Synthesis of short-pulse labeled fraction was also significantly inhibited, however it was preferential in a relationship to the other fractions. m-RNA synthesized in the presence of glucose showed the same rate of degradation regardless if taking place in presence or absence of energetic source. A possible correlation between a decreased turn-over of m-RNA and preference of repair of uv irradiation damaged genetic information is discussed. (tr-auth)

40971 CORRELATION OF VIABILITY OF IRRADIATED AND NONIRRADIATED ESCHERICHIA COLI B CULTIVATED ON VARIOUS CULTURE MEDIA. Myasnik, M. N.; Korogodin, V. I. (Inst. of Medical Radiology, Obninsk, USSR). Radiat. Res., 34: 661-8 (1968).

Experiments showed a high correlation between the survival of γ irradiated E. coli B and the viability of nonirradiated E. coli B, plated on various media at various temperatures. The degree of the effect of the media after irradiation with doses of 20 kR can be ten- to twentyfold. The dependence of the survival of irradiated bacteria on postirradiation conditions is well known and is usually interpreted as a recovery effect. The data indicate that variation in the levels of survival of irradiated cells may be caused by a selective effect of the medium. To distinguish between these two hypotheses, additional investigations are required. (auth)

40972 PERSISTENCE OF X-RAY-INDUCED LETHAL SECTORING IN YEAST. James, A. P.; Werner, M. M.; Saunders, A. S.; Harris, M. A. (Chalk River Nuclear Labs., Ont.). Radiat. Res., 34: 475-87(1968).

X-ray-induced lethal sectoring, a frequently occurring type of dominant lethal damage, was studied in Saccharomyces cerevisiae by pedigree analysis, in which the fate of various vegetative lines of descent from individual irradiated cells was determined. A propensity for sectoring was associated with a reduced rate of cell division, and lines of descent in which lethal sectoring persisted indefinitely could be isolated. The lethal sectors produced by an unstable line usually consisted of only one or two dead cells. The degree of instability, as measured by frequency of sectoring, was variable, and it was possible to isolate sublines with greater or lesser degrees of instability by a technique of selective serial transfer. Mechanisms which may be responsible for lethal sectoring are discussed, and it is concluded that one of the more likely of these involves the misassortment of extrachromosomal entities at cell division. (auth)

40973 MITOTIC RECOMBINATION INDUCED BY ULTRAVIOLET LIGHT IN SYNCHRONOUS CULTURES OF YEAST.

Parry, James M.; Cox, B. S. (Botany School, Oxford). Mutat. Res., 5: 373-84(May-June 1968).

Samples taken at intervals from a synchronized mitotic diploid culture of Saccharomyces cerevisiae were treated with ultraviolet light with photoreactivating white light. They were scored for survival and for the incidence of intergenic and intragenic recombination. It was found that the frequency of all three events varied through the cycle, cell death and intergenic recombination reaching peaks during DNA synthesis and intragenic recombination at the end of DNA synthesis. The periods of maximum photoreactivation coincided with periods of maximum induction of a given event by the ultraviolet light. While cell death showed some photoreactivation at all stages of the cycle, both kinds of uv-induced recombination at some stages responded hardly or not at all to photoreactivating light. The interpretation of the results is discussed. (auth)

40974 RADIATION INDUCTION OF PROPHAGE OF ESCHERICHIA COLI 3310 (λ) IN RELATION TO CULTURE AND RADIATION CONDITIONS. Noack, Dieter; Scherneck, Siegfried (Inst. for Microbiology and Experimental Therapy, Jena, Ger.). Strahlentherapie, 135: 109-17(1968). (In German).

Depending on the physiological condition, a different kinetic behavior in the induction effect on lysogenic bacteria cells was observed after uv and x radiation. In order to explain this observation, two effective target areas are assumed. One of those might be the pool of desoxyribonucleotides, and the other the pool of allosteric proteins. The function of the nucleobases as effectors for allosteric proteins (repressors, polymerases, replicases) seems to be of importance. (auth)

40975 INACTIVATION AND PHOTOREACTIVATION INDUCED BY ULTRAVIOLET RADIATION. Nashimoto, Hiroko; Uchida, Hisao (Tokyo Univ.). Tanpakushitsu Kakusan Koso, 11: 265-8(Apr. 1966). (In Japanese).

The uv-radiation-induced inactivation and photoreactivation of coli bacterophage were studied. In the experiments described the phage suspension 1×10^9 ml was irradiated with 2537 Å uv light for 10, 20, 30, or 60 sec for T_2 phage, and 20, 40, 60, or 120 sec for T_4 phage. After irradiation, one-half of the sample plates was incubated in darkness and the rest exposed to fluorescent light for two hr before being placed in the incubator. Ultraviolet inactivation of the phage was observed in the samples incubated in darkness, while photoreactivation was demonstrated in those exposed to visible light after irradiation. The uv-inactivated phage also showed reactivation when they were used to infect the cells repeatedly and with multiple strains (multiplicity reactivation). In this experiment the irradiated and nonirradiated phages were incubated at 2×10^8/ml with Escherichia coli B and the frequency of the multiplicity reactivation in the irradiated phage was calculated. In other experiments, the analyses of the rII mutation, functional allelism, and transmission of rII were studied. Mixed infection with mutated A cistron and mutated B cistron phages resulted in the multiplicity reactivation. However, mixed infection with two mutated A cistrons or two mutated B cistrons did not. (BBB)

40976 PROBLEMY POSTRADIATSIONNOGO VOSSTANOVLENIYA. (Problems in Postirradiation Recovery). Korogodin, Vladimir Ivanovich. Moscow, Atomizdat, 1966. 390p.

A discussion of the recovery of cells from injuries incurred by ionizing radiation resulting in inactivation and death is presented. Data from experiments with yeast cells and on literature on cell recovery and related radiobiological problems are included. Recovery from such radiation effects as inhibition of growth, inhibition of division, delay in DNA synthesis, physiological injuries in chromosomes, and biochemical and lethal mutations is not dealt with, and data on chromosome aberration and the mutation of genes are included only when they relate to the lethal consequences of exposure to ionizing radiation. There are 737 references of which 278 are Soviet. This book is intended for radiobiologists. (ATD)

Radiosterilization and Radiopreservation

Refer also to abstract 40898.

40977 (JEN-175-SI/I-16) CONSERVACION DE ALIMENTOS POR IRRADIACION. IV. INVESTIGACIONES PRELIMINARES EN LIMONES. (Conservation of Food by Irradiation. IV. Preliminary Investigations of Lemons). Del Val, M.; Ortin, N.; De Mateos, A. G. (Junta de Energia Nuclear, Madrid (Spain). Seccion de Isotopos). 1966. 9p. (In Spanish). Dep.

The optimum radiation dose to increase the storage life of lemons, as well as the effects of γ radiation on the weight loss, texture and color of the fruits were studied. Changes of internal conditions, ascorbic acid content, and viscosity, density and refractive index of juices are described. Significant increases in the storage times were observed in lemons after irradiating at levels of 50 Krad. (40 days versus 15 for blanks). (auth)

40978 (NP-17182) SEIBERSDORF PROJECT ON FOOD IRRADIATION RESEARCH. INTERNATIONAL PROGRAMME ON IRRADIATION OF FRUIT AND FRUIT JUICES. First Activity Report, January 1, 1965–December 31, 1966. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna. European Nuclear Energy Agency, Paris (France). International Atomic Energy Agency, Vienna (Austria)). Sept. 1967. 49p. Dep.

A brief survey of the research carried out on the (^{60}Co) γ radiation processing of apple and grape juice is presented. Chemical and physical factors affecting the radiosensitivity of Saccharomyces cerevisiae var. ellipsoordeus and Phialophora mustea (organisms responsible for fermentation); volatile compounds formed in the juices following irradiation, heating, or freezing; and wholesomeness and toxicity of the irradiated juices for rats, mice, and miniature swine were investigated. A list of the 33 publications issued during the research year is also included. (B.S.L.)

40979 (THAI.-AEC-8) CERTAIN PAPERS PRESENTED AT THE SEMINAR ON INSECT ERADICATION BY IRRADIATION, 28-29 JUNE 1966. (Office of Atomic Energy for Peace, Bangkok (Thailand)). Dec. 1966. 63p. (CONF-660666). Dep.

Results of studies on eradication of insects by irradiation as studied at the Office of Atomic Energy for Peace in Thailand are presented. Problems of insect populations and their control; some entomological aspects in radiobiological effects; radioisotope labeling of insects, and current activities in radiation entomology were the opening papers. These were followed by papers on the use of γ radiation to kill silkworm pupae prior to the removal of silk from the cocoon and the subsequent effects of the radiation on the silk fiber; the effects of γ radiation on the nutritive value of rice; biology of the rice stem borer (Chilotraea polychrysa); and the use of γ radiation in the control of the following insects: pea weevil (Callosobruchus chinensis), cigarette beetle (Lasioderma serricorne), red flour beetle (Tribolium castaneum), rice weevil (Sitophilus oryzae), angoumois grain moth (Sitatroga cerealella), and the Oriental fruit fly (Dacus dorsalis). (B.S.L.)

40980 SELF-STERILIZATION BY RADIUM CELLS. Kaselow, Dietrich; Schumann, Eberhard; Sproessig, Martin (Inst. for Medical Microbiology, Erfurt, Ger.). Strahlentherapie, 134: 45-52 (Sept. 1967). (In German).

The impossibility of obtaining an exact dose rate at all surface points of radium preparations and the different reports about the inactivation doses for bacteria were mentioned. The reason for experimentally investigating the problem of self-sterilization of radium sources was discussed. Radium cells (10 mg) were used as radiation sources and Escherichia coli were used as a test-bacterium. In the case of these relatively radiation sensitive bacteria, sterility of the radium cell surface was obtained only after a radiation exposure over a period of six days. This showed that the self-sterilization was not possible within a reasonable time as used in hospitals, especially in the cases of more resistant organisms or in the case of preparations with unfavorable size and location of the activity. Disinfection substances were very suitable for surface sterilization of the radium cells; this was confirmed in experiments with peracetic acid. (auth)

40981 THE BIOLOGY, BREEDING, AND STERILIZATION OF THE CABBAGE FLY PHORBIA BRASSICAE BOUCHE, WITH SPECIAL CONSIDERATION OF ITS OCCURRENCE IN BLACK RADDISH CULTIVATION. RESEARCH ON STERILIZATION BY RADIOACTIVE IRRADIATION. Riedel, Martin. Bayer. Landwirt. Jahrb., 44: 414-29(1967). (In German).

It was shown that Phorbia brassicae was very radiosensitive. Gamma radiation doses of more than 2 kR caused complete sterility of both sexes. The most favorable irradiation stage was during the last four days before metamorphosis into the imago (at 20°C). The radiosensitivity of the body tissue depended essentially on the developmental stage of the pupa. If the insects were irradiated more than four days before the imago stage, visible somatic damage occurred that was expressed by a shortened lifetime of the imago, wing incapacity, and increase of pupa mortality. On practical grounds, irradiation was recommended during the pupa development; its effect at this time was approximately the same as in the irradiation of newly developed imagos. Laboratory studies showed that sterile males could compete with fertile males only at irradiation doses under 3 kR. Irradiation of pupa earlier than four days before metamorphosis led to a signifi-

cant decrease in the sexual activity of the males. At irradiation doses of 2 to 2.5 kR, the sterile males were completely competitive with the fertile males. Greenhouse studies were carried out with sterile males from mass breeding and with fertile flies collected in the open as pupa. These studies showed that these sterile males could compete with the fertile males only when they were of the same size as the fertile males. (tr-auth)

40982 STUDIES IN DEPILATION. III. USE OF GAMMA RADIATION IN THE STERILIZATION OF SHEEPSKINS FOR ENZYME DEPILATION STUDIES. Yates, J. R. (Commonwealth Scientific and Industrial Research Organization, Parkville, Australia). Radiat. Res., 34: 648-60(1968).

Sheepskin collagen was irradiated in the dry state (13 to 17% water content), and in the green (undried) state (60 to 67% water content), with doses from 1 to 20 megarads. Irradiation at any dose level causes some irreversible degradative changes to occur in the skin collagen, as manifested by a decrease in shrinkage temperature. These changes are more severe when the skins are irradiated in the dry than in the green state, and the damage cannot be fully compensated for by the introduction of new interchain cross-links in the tanning process. Irradiation changes the properties of the skins, and the water uptake, swelling (at neutral pH), and percentage loss of weight on soaking are all reduced. Doses of as high as 5 megarads do not confer long-term sterility on sheepskins; furthermore, skin damage at this dose level is such as to preclude its use in practice as an alternative method of preservation to air drying. A dose of 3 megarads, however, will confer adequate short-term sterility over the course of laboratory enzyme depilation experiments, but wool loosening proceeds slowly even after a 5-megarad dose. Irradiation of a number of commercially available depilatory enzyme systems with a 5-megarad dose causes virtually no reduction in proteolytic activity, nor does it kill all the bacteria present in the preparations. (auth)

40983 DO IRRADIATED FOODSTUFFS HAVE A RADIOMIMETIC EFFECT? II. NUTRITION TESTS ON MICE WITH WHEAT FLOUR IRRADIATED WITH UP TO 5 MEGARAD. Bugyaki, L.; (Institut d'Hygiene et d'Epidemiologie, Brussels) Deschreider, A. R.; Moutschen, J.; Moutschen-Dahmen, M.; Thijs, A.; Lafontaine, A. Atompraxis, 14: 112-18(Mar. 1968). (In German).

Nutrition tests were made on mice in order to study the innocuousness of irradiated foodstuffs. The food fed the mice contained 50% wheat flour that had been irradiated with up to 5 megarad (^{60}Co gamma rays). The test series covered a whole generation of mice. Chemico-physical analysis of the flour indicated that it had undergone extensive changes. Of the data obtained from observing the animals during the tests, the ratio of albinos, the number of births, and the hematological values showed no significant difference between treated and control animals. In contrast, life span, fertility, and frequency of tumors were unfavorably influenced in the treated animals. Cytogenic analysis of meiotic cells in the mouse litters also showed a higher quota of chromosome disturbance. The results are presented without any positive conclusions. However, emphasis is placed on the necessity of using more subtle methods in future examinations, and on the importance of comparing the noxious effects of irradiation with those resulting from other methods of food preservation. (auth)

40984 RADIATION TREATMENT OF FOODS. I. RADURIZATION OF FRESH EVISCERATED POULTRY. Idziak, Edmund S.; Incze, Kalman (McGill Univ., Montreal). Appl. Microbiol., 16: 1061-6(July 1968).

Radurization processing of fresh eviscerated poultry was microbiologically studied. The recommended dose of 0.5 Mrads extended the shelf life at 5 C by approximately 14 days. This treatment also effected a 10 and 11 log reduction in the number of viable Salmonella species and Staphylococcus aureus strains, respectively. Recycling these organisms at sublethal doses of irradiation resulted in strains possessing increased irradiation resistance. Shifts in the microbial ecology after irradiation and storage resulted, in some instances, in the isolation of organisms tentatively identified as Moraxella sp. and Herellea vaginicola. (auth)

40985 STUDIES ON THE STORAGE OF CHESTNUTS TREATED WITH γ-RAY. Park, Nou Pung; Kim, Yeun Sik; Choe, Eon Ho. J. Nucl. Sci. (Seoul), 7: No. 2, 1-6(1967). (In Korean).

Korean chestnuts (Dang Jin, HaDong) were γ-irradiated with ^{60}Co at 12, 28, 45, and 60 krad two months after harvest to investigate inhibition of rotting and sprouting. Storage was in moist sawdust at 18 to 20°C. Observations were made for six months. Two varieties of chestnuts showed considerable inhibition of rooting and sprouting though little difference between each dosage. After three months of storage, the numbers of rotting chestnuts increased rapidly with no relation to γ-ray treatment. Respiration in the control lot increased rapidly from the time of sprouting. In the irradiated lot it increased just after treatment and then gradually decreased. The reduced sugar value in the control lot peaked and then decreased while it remained higher in the irradiated lots throughout the storage period. Reduced ascorbic acid decreased a little in the irradiated lot as compared to the control lot and the rate of decrease was greater in the irradiated lot, especially at the end of storage. (C.O.)

40986 STUDIES ON THE STORAGE OF SWEET POTATOES WITH GAMMA-IRRADIATION. I. Park, Nou Pung; Kim, Yeun Sik; Choe, Eon Ho. J. Nucl. Sci. (Seoul), 7: No. 2, 13-19(1967). (In Korean).

Some changes were observed in the outward appearances, weight, respiration, and composition of sweet potatoes during three months' storage after irradiation with ^{60}Co-γ rays at 0.125 to 2.0 mrad just before the time of natural sprout. Just after irradiation, dark brown color of the surface skin and destruction of the tissues occurred at doses above 1.0 mrad. The sprout was inhibited during the period of storage in all irradiated lots. The results were best at 0.125 mrad. (auth)

40987 APPLICATION OF IONIZING RADIATIONS IN STERILIZATION OF FOODS AND PHARMACEUTICALS. Todorov, Sv.; Keslev, D. Rentgenol. Radiol., 7: 69-76(1968). (In Russian).

A brief review is given on developments in the γ radiopasteurization and radiosterilization of stored food products and on radiosterilization of medical products, pharmaceuticals, and biological materials. 28 references. (R.V.J.)

40988 GAMMA RAYS, POTATO SPROUT INHIBITORS. Sandret, F.; Michiels, L. (Lab. de Biochimie, Massy, France). Ind. Aliment. Agr., 83: 1189-99(Sept.-Oct. 1966). (In French).

The effects of irradiation on potatoes and especially on the sprouting of potato tubers were studied. First the characteristics of ionizing radiation were described and the effects of different doses on various forms of food products were tabulated. Then the effect of γ rays on the physiology of potato tubers of the Bintje and Kerpondy varieties was described. A dose of 8000 to 12,000 rad inhibited germination. Furthermore, modifications in respiratory and glycolytic metabolism were produced. Release of CO_2 and consumption of O_2 were increased. The soluble sugar content, especially sucrose, was higher. However, in long-term experiments, tubers underwent no further physiological changes. In spite of sprouting control, the progressive accumulation of soluble sugar occurred. Extensive investigations demonstrated the feasibility of irradiation treatment of potatoes and the wholesomeness of irradiated tubers. Details were given of progress in the field up to this time as well as prospects for the future. (BBB)

40989 RADIOINDUCED CHANGES ON BEEF FAT-CEPHALIN MIXTURES BY GAMMA RADIATION. INHIBITION OF cis-trans ISOMERIZATION. Kohn, Rudolf (Army Natick Labs., Mass.). J. Amer. Oil Chem. Soc., 45: 63-6(Feb. 1968).

A simple and exact method was sought for detecting radiation treatment especially for relatively low doses, e.g., 4 to 5 Mrad, applied to meat. It was observed that after irradiation by β or γ rays, fats show cis-trans isomerization of double bonds in addition to other chemical changes. Cephalin dipalmitate was added (0.5, 1.0, 2.0 and 5.0% w/w) to beef fat that had been extracted from beef adipose tissue by petroleum ether. Samples of the mixture, in sealed glass ampoules, part after evacuation (10^{-3} torr) for 3 hr and part in air to insure adequate oxygen, underwent ^{60}Co γ irradiation (dose rate 0.75 Mrad/hr) at 6, 10, 25, 50, and 100 Mrad doses. The IR spectra of beef fat and beef fat-cephalin mixtures, irradiated at doses from 6 to 100 Mrad in vacuum or in air differed only slightly. The most prominent differences occurred at 10.35 μ (966 cm^{-1}) where absorption was attributed to the C-H deformation of isolated trans double bonds. A distinct inhibition of trans isomerization resulted from the addition of cephalin. The observed inhibition was independent of the amount of added cephalin from 0.5 to 5.0% by weight of the beef fat. The decreased absorption was dose-dependent, but oxygen-independent. Reactions in the dose range 6 to 25 Mrad appeared to differ from those in the dose range 25 to 100 Mrad. Some suggested explanations were offered for these phenomena. (BBB)

40990 EFFECT OF IONIZING RADIATION ON FOOD PRODUCTS. Petrusca, J. Rev. Sanit. Mil., 63: 285-7(Mar.-Apr. 1967). (In Rumanian).

Data on polymerization or depolymerization, oxidation and reduction and other chemical and physical changes due to the effect of ionizing radiation on various types of food, and the radiation dose used are presented. (JPRS)

40991 OBSERVATIONS ON RADIATION-STERILIZED SUGAR AND ITS MICROBIOLOGICAL EFFECTS. Kiss, Istvan; Farkas, Jozsef; Andrassy, Eva; Beczassy, Katalin (Central Food Research Inst., Budapest). Acta Microbiol. Pol., 17: 67-74(1968).

The suitability of ionizing radiation for sterilization of sugar used in the canning of peas was studied, and changes in the sugar caused by irradiation and subsequent heat treatment were investigated. When crystallized commercial beet sugar was treated with x rays, canned peas prepared with the irradiated sugar were not spoiled at 30 or 55°. The pea samples containing unirradiated sugar showed spoilage. As an effect of irradiation (above 0.5 Mrad) the sugar showed pink discoloration. The uv spectrum of the solution of the irradiated sugar had a maximum at 265 mμ, and the reducing power of the solution increased with increasing dose level. Particularly high reducing power was observed in the solution of irradiated sugar after heat treatment. The pH of the solution decreased as a function of dose level and this was enhanced by heat treatment. The presence of large amounts of glucose and fructose was demonstrated by paper chromatography. Germination of Bacillus coagulans spores was stimulated by the irradiated sugar. (BBB)

40992 THE EFFECT OF GAMMA RADIATION FROM A ^{60}Co SOURCE ON AQUEOUS SOLUTIONS OF CHLOROBUTANOL, THEOPHYLLINE, AND SODIUM CARBOXYMETHYLCELLULOSE PACKAGED IN GLASS AND POLYETHYLENE CONTAINERS. Rasero, Lawrence Joseph Jr. Storrs, Conn., Univ. of Connecticut, 1966. 130p.

Thesis.

The purpose of this investigation was to study the effect of gamma radiation on selected aqueous pharmaceutical systems. The investigation consisted of three phases. The first phase was the study of the effect of gamma radiation on aqueous solutions of chlorobutanol packaged in glass and polyethylene containers. The chlorobutanol solutions were investigated for degradation of chlorobutanol, pH changes, and formation of hydrogen peroxide, acetone, and chlorine. The second phase was the study of the radiation effects on aqueous solutions of theophylline packaged in glass and polyethylene containers. The theophylline solutions were investigated for degradation of theophylline, pH changes, and formation of hydrogen peroxide. The third phase was the study of the effect of gamma radiation on aqueous solutions of sodium carboxymethylcellulose, also packaged in glass and polyethylene containers. These solutions were studied for changes in viscosity and molecular weight. Gamma radiation was found to cause degradation in all three systems studied. On a percent basis, the degradation of chlorobutanol was less, the more concentrated the solution. The total milligram loss of chlorobutanol at first increased as the concentration increased, but then reached a maximum value, above which the total milligram loss remained relatively constant, regardless of concentration. The irradiated chlorobutanol solutions were also found to produce acetone, hydrogen peroxide, chloride ions, and an amorphous precipitate that was not identified. The percent degradation of theophylline was also found to be less, the more concentrated the solution. The total milligram loss of theophylline remained relatively constant, however, regardless of the concentration of the solution. Hydrogen peroxide was also produced in the theophylline solutions. Irradiation of aqueous solutions of sodium carboxymethylcellulose led to a severe reduction in viscosity, a reduction in the intrinsic viscosity, and a change in the flow curves from a pseudoplastic curve to a near Newtonian curve. No container effect was noted for the systems investigated. (auth) (Disser. Abstr.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 40307 and 41083.

40993 (COO-1198-534) ANNUAL PROGRESS REPORT [ON SCIENCE OF MATERIALS]. (Illinois Univ., Urbana. Materials Research Lab.). Apr. 15, 1968. Contract AT(11-1)-1198. 74p. Dep. CFSTI.

Structure of materials, solid state physics, and energetic particle interaction are reviewed covering a total of 18 papers. A synopsis is given for each paper on object, present results, and projected results expected and work to be performed. The significant results include studies of self-diffusion of Ni in Ni-Co alloys showing that stacking faults provide paths of enhanced diffusion in these crystals. High purity niobium crystals were grown in a vacuum of 10^{-10} torr. A theory of composite martensite which accounts satisfactorily for the "225" and "259" habits in steels was generalized to describe martensite plates with other habits. Nuclear magnetic resonance studies of impurities in aluminum demonstrated that the electric quadrupole contribution to the local field is a major source of the resonance relaxation which therefore depends strongly on the properties of the solute. It was established that the contribution of the conduction electrons in aluminum to the third order elastic constants is significant. A general treatment was also given of the thermodynamic properties of crystals containing defects. Single crystals of helium were grown at pressures as high as 1000 atm and obtained preliminary measurements of the thermal conductivity. Lattice constant and thermal expansion measurements were made on ^{20}Ne and ^{22}Ne crystals. A study of the spin-flip conduction electron scattering from impurities in liquid metals was made. Thermal conductivity measurements on titanium carbide suggest that the carbon atoms are arranged on the carbon sublattice in a manner similar to that observed in the glassy state. Koehler's radiation damage group established that interstitial atoms in gold are mobile at 130°C. Stage II annealing was absent in very pure specimens of electron irradiated gold and all damage annealed during Stage III. The mechanism of Stage III annealing was found to be the migration of vacancies to interstitial clusters. It appears that these cultures are platelets on (111) planes which nucleate at impurities. (J.C.W.)

40994 BERYLLIUM: LOW-OXIDE FINE GRAIN WROUGHT BERYLLIUM. Hanes, H. D.; Zurey, F. T. Light Metal Age, 25: 12; 14(Dec. 1967).

The effect of high purity on the mechanical behavior of fine-grained Be sheet and the production of Be by splat cooling, to produce a low-oxide, fine-grained material are discussed. The production of composites of Be wire in matrices of Al, Ti and their alloys were made and tested. The mechanical behavior of Be-wire-reinforced plastic composites was studied (composites of Be wire combined with an epoxy resin were fabricated and their mechanical behavior in tension, compression, flexure and shear-loading modes was determined). An examination of micro-composites of Ti alloys and Be to improve the yield strength and elastic modulus of Ti while lowering its density and maintaining the ductile matrix of Ti and the fabricability of complex aerospace structures from commercial Be sheet and the predictability of the strength levels of these structures are reported. A study of the properties of Be for use in rocket engines is made. (auth)

Corrosion and Erosion

Refer also to abstracts 40338, 41032, 42194, and 42397.

40995 (AECL-2800) SOME OBSERVATIONS OF INTERGRANULAR CORROSION ON IRON AND NICKEL. Bryant, P. E. C.; LeSurf, J. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1968. 31p. (CONF-680313-2). Dep. CFSTI. CAN $1.00.

From 24th Annual National Association of Corrosion Engineers Conference, Cleveland, Ohio.

Intergranular corrosion detection on carbon steel, Monel 400 and Inconel 600 is reported after the specimens were exposed to irradiated water and steam and unirradiated water. Results are tabulated. Nitrate ion up to 10 ppM did not promote intergranular attack on carbon steel and Monel 400 in the absence of oxygen, but may have contributed to progression of intergranular cracking in plastically deformed Inconel 600 specimens. Integranular attack of the alloys was prevented, and crevice propagation arrested in irradiated boiling water by maintaining the ammonia concentration in excess of 10 mg/kg in the water phase. Oxidizing species produced from radiolytic decomposition of boiling water are suggested as the primary cause for the observed intergranular corrosion. (J.C.W.)

40996 (CONF-680605-1) REPORT ON CATHODIC PROTECTION OF UNDERGROUND PIPING SYSTEMS AT THE PADUCAH GASEOUS DIFFUSION PLANT. Burkhalter, L. C.; Shelton, M. F.; Tomlinson, E. H. (Paducah Gaseous Diffusion Plant, Ky.). [nd]. Contract W-7405-eng-26. 18p. Dep. CFSTI.

From Conference on Cooling Towers, Los Angeles, Calif.

Equipment and procedures, used at the Paducah Gaseous Diffusion Plant, to inhibit electrolytic corrosion of underground cast iron and steel water lines are discussed. (P.G.C.)

40997 (N-68-13805) HIGH-TEMPERATURE PROTECTIVE COATINGS FOR REFRACTORY METALS. Progress Report, July 21-October 21, 1967. Rexer, J. (Union Carbide Corp., Parma, Ohio. Carbon Products Div.). [1967]. Contract NASw-1405. 11p. (NASA-CR-91537; PR-6). CFSTI.

Progress is summarized in a program to (1) measure the change in thickness of an iridium coating on the refractory metals tungsten, molybdenum, and niobium due to interdiffusion and intermetallic compound formation, and (2) examine microscopically with a microbend tester the mechanical behavior of iridium coated and heat treated specimens. It is reported that construction of a microbend tester was completed, and that the performance of the device was checked using small strips of steel. The flexural strength values obtained for grade ATJ graphite were compared with values obtained on standard size samples. Tests were conducted on polished strips of molybdenum and tungsten, and molybdenum-iridium diffusion samples were hot pressed. (STAR)

40998 (N-68-19623) OPTIMIZATION AND EVALUATION OF ELECTROPHORETIC PROTECTIVE COATINGS FOR TANTALUM T-222 ALLOY. Final Summary Report, July 1, 1966-October 27, 1967. Klach, S. J.; Ortner, M. H. (Vitro Labs., West Orange, N. J.). Dec. 1967. Contract NAS3-9405. 208p. (NASA-CR-72358). CFSTI.

Coating process parameters including composition, siliconization time, preoxidation time and temperature, and double versus single layer coatings were evaluated in order to improve the oxidation resistance and coating reliability of a variety of silicide coating systems. The coatings were evaluated in terms of oxidation life at 1500°F and 2400°F under cyclic conditions. The most promising systems developed consisted of either $MoSi_2-20TiSi_2$ or $MoSi_2-40CrSi_2$ coatings deposited over a VSi_2 barrier layer. These systems, at an overall thickness of approximately 2.5 mils, showed the capability of surviving 600 hours exposure at 1500°F and 2400°F, the $MoSi_2-20TiSi_2/VSi_2$ coating system yielded oxidation lives of 1398 hours and 824 hours, respectively. The specimen of the 1398 hour test was still intact after terminating the test program. Ductility was lacking, however. Excellent coating reproducibility was exhibited by the $MoSi_2-40CrSi_2/VSi_2$ coating system. Eight of the ten specimens tested (4 at each temperature of 1520°F and 2400°F) survived 626 hours of cyclic testing. The excellent performance is attributed to the oxidation resistance and self-healing capability of the VSi_2 underlayer. (auth) (STAR)

40999 (WAPD-TM-759) HYDROGEN BEHAVIOR IN ZIRCONIUM-BASED ALLOYS (LWBR DEVELOPMENT PROGRAM). Marino, G. P. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1968. Contract AT-11-1-GEN-14. 33p. Dep. CFSTI.

A quantitative model of diffusion and concomitant precipitation is used to explain the observed distribution of hydride precipitates during the isothermal corrosion of Zircaloy. A model is also included which accounts for the redistribution of the hydride phase when specimens containing a surface hydride film are thermally cycled. The models are based upon the assumptions that the α-phase of Zircaloy can supersaturate with hydrogen, and that precipitation of hydride is inhibited; e.g., by the local stresses resulting from the 10-20% volume expansion associated with the formation of δ-hydride. For the specific specimen geometry of corrosion coupons corroded on two sides, the solution of the mass balance 2nd order differential equation results in an expression for the steady-state concentration profile of hydrogen in the α-phase. From this expression, the rate of hydrogen absorption is readily calculated in terms of the diffusivity of hydrogen, D, the equilibrium solubility of hydrogen in the α-phase, C_{eq}, the half-thickness of the specimen, l, the concentration of hydrogen just inside the surface, C_s, and a precipitation parameter, K.

Since all of the above quantities except C_s and K are known, the theoretical expression is fitted to the data of Murgatroyd and Winton and numerical values of C_s and K are extracted. The importance of K is evident since, if the growth (thickening) of hydride is diffusion controlled, K ~ D/d (where d is the effective diffusion distance from the matrix to a hydride precipitate), and, if the growth of hydride is inhibited, K < D/d. The K extracted from the data is much less than D/d when d is taken to be one-half the average α grain diameter. Thus, the model is self-consistent in its assumptions and illustrates the importance of knowing K. The model also illustrates the effect of specimen thickness, 2l, upon the rate of hydrogen absorption (in ppm per unit time). It is shown that the rate in 3.0M LiOh is inversely proportional to l for $l \gtrsim 0.05$ cm and independent of l for $l \lesssim 0.02$ cm. Since the former variation is usually assumed in predicting hydrogen absorption, extrapolation to small thicknesses will result in grossly exaggerated estimates. The equation derived from the thermal cycling model predicts values of hydrogen concentration as a function of the number of cycles and cycling range which agree well with the data of Westerman. (auth)

41000 (WAPD-Trans-0092) METALLOGRAPHIC STUDY OF BREAK-AWAY DURING THE OXIDATION OF ZIRCONIUM. Keys, L. H.; Beranger, G.; De Gelas, B.; Lacombe, P. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from J. Less-Common Metals, 14: 181-200(1968). 27p. Dep. CFSTI.

The kinetics of the oxidation of zirconium in oxygen at elevated temperatures are characterized by the transition from a quasi-parabolic rate law to an apparently linear law for longer oxidation durations. Together with the occurrence of this kinetic transition, a continuous modification in the morphology of the oxide film leading to the "break-away" of the film is observed. A study of the structural changes of the oxide formed during the oxidation in the temperature range 700 to 1050°C has been performed by metallography; the occurrence of fissuring in the oxide film and the separation of a white oxide film from the black, metal-adherent oxide are shown and discussed especially in connection with the relative mechanical properties of the oxide and of the metal substrate. The various experiments described have led to a suggested mechanism for the break-away phenomenon. (auth)

41001 GRAIN BOUNDARY PENETRATION OF NIOBIUM (COLUMBIUM) BY LITHIUM. Brehm, W. F. Jr.; Gregg, J. L.; Li, Che-yu (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-3228. Trans. Met. Soc. AIME, 242: 1205-10(July 1968). (NYO-3228-12).

Oriented, oxygen-doped niobium bicrystals were tested in liquid lithium. The grain boundaries were attacked preferentially. The depth of the penetrated zone varies as $(\text{time})^{1/2}$. The penetration was anisotropic, had a high activation energy, and increased with the increased oxygen doping level. A possible model was proposed to account for the experimental observations. (auth)

41002 HIGH TEMPERATURE DIFFUSION COATINGS FOR REFRACTORY ALLOYS. TOMORROW'S COATINGS FOR TODAY'S ALLOYS. Maisel, L. (Chromalloy American Corp., West Nyack, N. Y.). Metal Finish., 66: 78-81(Jan. 1968).

Developments in the field of coatings for Nb, Ta, and W alloys are reviewed, with data presented on the creep-rupture behavior of several coated Nb alloys (Cr-Ti-Si/B66 TRW, Cr-Ti-Si/C129Y TRW, modified silicide B66, Ag-Si-Al/D43 and Ag-Si-Al/C129Y) at 10,000 psi tensile stress and their average 1-hr cyclic oxidation life. The oxidation protective life of coatings for Nb alloys is influenced by alloy, temperature, pressure, time, profile, strain, and coating thickness. The best developed coatings for Ta are the modified Sn-Al and silicides. Silicide coatings were also most suitable for protecting W alloys. Two evaluation techniques for coated alloys are discussed: the erosion test rig and the electron probe microanalyzer. (J.R.D.)

41003 CROLOY 16-13-3: HEAT AND CORROSION RESISTANT TUBING AND SHAPES. Alloy Dig., SS-202, 2p(Nov. 1967).

Croloy 16-13-3 (16-18% Ni, 2-3% Mo) is an 18-12 austenitic stainless steel which has better corrosion resistance than the 18-8 stainless steels. It has good abrasion resistance and excellent oxidation resistance. Maximum temperature limit for long life under oxidizing conditions is 1600°F. The alloy has superior resistance to creep at elevated temperatures. It is recommended for chemical plant and oil refinery equipment, heat exchangers and paper pulp processing equipment. (auth)

41004 CORROSION GUIDE. SECOND REVISED EDITION. Rabald, Erich. New York, American Elsevier Publishing Company, Inc., 1968. 932p. $60.00.

The behavior of materials, not only toward the pure corrosive media, but also towards technical mixtures is discussed. The resistance of materials to corrosive media under working conditions is demonstrated. The information contained in this guide is presented under the following headings: corrosive agents; trade names of materials (metallic and nonmetallic); hints on using the text; a bibliography; and corrosion data. (R.C.K.)

41005 PROPOSED MECHANISM FOR THE STRESS CORROSION FRACTURE OF A COPPER-BERYLLIUM ALLOY. Sylwestrowicz, W. D. pp 145-64 of Stress Corrosion Testing. From Symposium on Stress Corrosion Testing, Atlantic City, N. J. See ASTM-STP-425; CONF-660667.

Polycrystalline specimens of a copper-beryllium alloy (1.8 per cent Be) were bent and exposed to an ammonia atmosphere. Two lots of polycrystalline material of similar chemical composition but of different grain size and distribution of segregates were investigated. Specimens were subjected to different values of plastic deformation and humidity conditions. Plastic deformation appears to be an essential factor in stress corrosion fracture. The importance of humidity conditions was emphasized by the results obtained. Both modes of fracture, transcrystalline and intercrystalline, were observed. It was found that the distribution of segregates determines which of these two modes of fracture will occur. A mechanism of stress corrosion fracture in a copper-beryllium alloy is proposed. (auth)

41006 CORROSION AND PROTECTION OF BERYLLIUM IN TURBINE ENGINE APPLICATIONS. Mackay, T. L.; Gilpin, C. B. (Douglas Aircraft Co., Newport Beach, Calif.). Electrochem. Technol., 6: 235-40(July-Aug. 1968).

Beryllium, due to its light weight, was considered for jet engine applications. Bare beryllium forms a thin oxide film when exposed to high-humidity environments at 100°F; however, in the presence of aqueous sodium chloride at the same temperature, bare beryllium is severely pitted at local anodic sites. It was found for forged beryllium and high-purity, single-crystal beryllium that the most rapid dissolution rate was parallel to the basal plane. The severe pitting of beryllium in the presence of aqueous solutions containing chloride ions prompted the investigation of protective coatings. To simulate operating conditions in an engine compressor, coated specimens were alternately exposed to 5% salt solutions at 100°F for 16 hr and elevated temperatures for 8 hr. Aluminized coatings and anodized coatings offered good corrosion protection for beryllium in the presence of aqueous salt environments and temperatures of 600°F. (auth)

41007 SLURRY COATINGS FOR TANTALUM-BASE ALLOYS. Wimber, R. T.; Stetson, A. R. (International Harvester Co., San Diego, Calif.). Electrochem. Technol., 6: 264-9(July-Aug. 1968).

Silicide coatings developed for the tantalum-base alloy designated T222 (Ta-9.6W-2.4Hf-0.01C) afforded over 600 hr of protection at 870 and 1315°C during cyclic exposure in air. The coatings were applied in two steps. A modifier alloy was applied by slurry techniques and was liquid-phase or solid-state sintered in vacuum prior to siliciding by pack cementation. Addition of titanium and vanadium to molybdenum and tungsten yielded beneficial modifier alloys, whereas the addition of chromium showed no improvement. After siliciding, the 35W-35Mo-15Ti-15V modifier alloy exhibited the best performance; one sample survived 1064 hr of oxidation at 1315°C (2400°F). The excellent reliability of this same coating in exceeding the 600-hr goal was observed to be reproducible. The slurry coatings also protected the Cb752 and D43 niobium-base alloys. (auth)

41008 A PARAMETRIC STUDY OF ION-PLATED ALUMINUM COATINGS ON URANIUM. Bland, R. D. (Sandia Lab., Albuquerque, N. Mex.). Electrochem. Technol., 6: 272-8 (July-Aug. 1968).

Ion-plated aluminum coatings were found to provide excellent corrosion protection on unalloyed depleted uranium when exposed to an accelerated (100°C — 1 atm water vapor pressure) corrosion test. This study was undertaken to determine what process parameters influence the coating properties and to optimize processing conditions for maximum corrosion protection. The parameters that influenced corrosion protection were: substrate precleaning, amount of gaseous contamination in the glow discharge, sputter cleaning voltage and pressure, filament contamination, deposition rate, and amount of Al-U interdiffusion, either during plating or in subsequent vacuum heat treatment. A diffusion layer consisting of uranium-aluminum intermetallic compounds is believed to provide the corrosion protection in this system. (auth)

41009 PROTECTIVE COATING FOR TITANIUM AND ZIRCONIUM. (to Continental Titanium Metals Corp. GmbH). British Patent 1,116,707. June 12, 1968. Priority date May 24, 1965, United States.

An aqueous solution of potassium silicate, containing a wetting

agent, is applied to matte or polished surfaces of articles of Ti, Zr, or their alloys to provide a transparent coating of potassium silicate and prevent blemishing, heat discoloration, corrosion, and minor scratches. (P.G.C.)

41010 PITTING OF TITANIUM ALLOYS IN SALINE WATERS. Posey, F. A.; Bohlmann, E. G. (Oak Ridge National Lab., Tenn.). Desalination, 3: 269-79(1967).

Electrochemical aspects of the corrosion of Ti and some of its alloys were studied in flowing, high-temperature salt solutions at temperatures up to 220°C in a Ti loop facility. Measured polarization curves showed that a pitting potential exists at sufficiently high potentials for all the alloys. Increase of temperature greatly affected the pitting potentials of Ti alloys. Plots of pitting potential as a function of temperature were reproducible and characteristic of each grade of Ti alloy and show clearly which alloys are superior in tendency towards pitting attack. The results suggest an upper temperature limit of usefulness for many Ti alloys without risk of severe localized attack. Alloys of Ti which contain Mo show promise for application in high-temperature saline waters. (BBB)

41011 CORROSION BEHAVIOR OF STAINLESS STEEL IN HIGH-TEMPERATURE WATER AND STEAM. Maekawa, Tatsuo; Kagawa, Masaru (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan). Nippon Kinzoku Gakkaishi, 31: 1213-19(Oct. 1967). (In Japanese).

The corrosion behaviors of AISI 304 and 304L stainless steels were studied to clarify the effects of temperature, surface finish, and dissolved oxygen in high-temperature water and superheated steam. In degassed water, the steels indicated a maximum corrosion rate between 250 and 350°C, and the corrosion rate was affected largely by the surface finish. In aerated water, the corrosion rate was not so much affected by the corrosion temperature and surface finish. In superheated steam, the corrosion rate increased with increasing temperature and was affected markedly by the surface finish at high temperatures. The corrosion films produced in degassed water and in steam consisted of magnetite and chromite, and the chromite content increased with increasing temperature, whereas those produced in aerated water consisted of γ Fe_2O_3. The α phase transformed from the γ phase by cold-working or surface abrading decreased the corrosion resistance in degassed water, but it greatly increased the corrosion resistance in superheated steam. (NSA of Japan)

Preparation and Fabrication

Refer also to abstracts 40295, 40341, and 42572.

41012 (N-68-18610) OXIDE DEFORMATION AND FIBER REINFORCEMENT IN A TUNGSTEN METAL OXIDE COMPOSITE. Blankenship, Charles P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 41p. (NASA-TN-D-4475). CFSTI.

Refractory oxide particles of UO_2 and ZrO_2 were added to a tungsten matrix and elongated into fibers by hot extrusion. Extrusion temperatures ranged from 3200 to 4000°F. The geometry of the oxide fibers appeared to be closest to that of an ellipsoid with the major axis alined in the extrusion direction. Oxide fibering was measured by an average length-to-width ratio of the fibers sectioned parallel to the major axis. The extent of oxide deformation was estimated in terms of strain components. Oxide-matrix deformation characteristics were related to the extrusion parameters by comparing the estimated oxide strain components to those of the composite. (auth) (STAR)

41013 (N-68-18973) BERYLLIUM FABRICATION METHODS DEVELOPMENT PROGRAM: THERMAL TREATMENT. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). July 2, 1965. Contract NAS8-11798. 63p. (NASA-CR-61659; LMSC/A-758461). CFSTI.

This report documents the thermal treatment techniques investigated and evaluated for possible application in the fabrication of beryllium aerospace vehicle structures. The effects of time and temperature on the removal of residual stresses, induced by prior work, are evaluated. The physical, mechanical, and dimensional changes resulting from varying rates of rapid cooling are reported, and the effects of prolonged exposure at high temperatures on the mechanical properties of beryllium sheet are investigated. (auth) (STAR)

41014 DISCUSSION ON "THE ROLE OF POWDER METALLURGY IN NUCLEAR TECHNOLOGY". Paris, R.; Tracey, V. A. Powder Met., 11: 203-11(Spring 1968).

Subjects discussed included control material manufacture, production of W alloys, stainless steel filters, impurity effects, Mg alloys, dispersion strengthened ferritic steels, SAP, and mixed oxide and coated particle fuels. (UK)

41015 CYROGENICS: SOLUTION TO ELECTRODE STICKING. Partridge, Frank M. (LTV Vought Aeronautics Div., Dallas). Tool Mfg. Eng., 59: 44-6(Oct. 1967).

Electrode sticking in resistance spot welding can be minimized by cryogenic cooling of the welding electrodes. Liquid nitrogen is routed through the water-coolant passages of both the upper and lower electrodes. By using waste nitrogen gas to mask the electrodes from the atmosphere, frost buildup is prevented and welding efficiency is enhanced. Initially developed for welding refractory metals, the technique is also applicable to Cu, Al and galvanized steel. Shear strength of refractory metals (Ta, W, Nb and Mo) and conventional metals (Al, stainless steel, Ti, 2024 Al alloy), welded by conventional and cryogenic spot welding techniques, is compared. (auth)

41016 MASS SPECTROMETRIC MEASUREMENT OF THE DIFFUSION OF URANIUM IN TUNGSTEN AT HIGH TEMPERATURES. Schwegler, Erwin Christian Jr. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 163p.

Thesis.

The diffusion rates of uranium in tungsten between 1760 and 2730°C were measured using a mass spectrometric technique. The mass spectrometer was also used to detect the allotropic phase change in zirconium at 863°C by measuring the diffusion rates of rubidium in zirconium between 760 and 1030°C. The diffusion coefficient of uranium in tungsten, between 1970 and 2730°C, followed the relation $D = (1.80 \pm 1.05) \times 10^{-2} \exp [-93{,}000 \pm 6500 \text{ (cal/mol)}/RT]$. The allotropic phase change in zirconium at 863°C was detectable from the abrupt change in rubidium diffusion rates at that temperature. The temperature dependence of the diffusion coefficient of rubidium in β-zirconium, between 880 and 1030°C, was given by $D = (8.80 \pm 2.90) \times 10^{-4} \exp [-36{,}700 \pm 600 \text{ (cal/mol)}/RT]$. In α-zirconium, in the temperature range between 760 and 863°C, before the sample was subjected to the allotropic phase transition, the rubidium diffusion coefficient followed the temperature relation $D = (1.17 \pm 0.73) \times 10^{2} \exp [-61{,}000 \pm 1000 \text{ (cal/mol)}/RT]$. After the sample was cycled in temperature through the phase change, this relation became $D = (1.30 \pm 0.60) \times 10^{-2} \exp [-41{,}500 \pm 800 \text{ (cal/mol)}/RT]$. To measure the diffusion coefficients, thin filaments of the solvent metals, each of which contained a low concentration of solute material as an impurity, were used as high temperature thermal ion sources in a mass spectrometer. Because of the low mass spectrometer source chamber pressure, the solute atoms evaporated from such a filament as soon as they diffused to its surface. A fraction of these solute atoms was ionized at the hot surface according to the Langmuir-Saha relation. These ions were accelerated, mass analyzed, and detected by the mass spectrometer. The desired diffusion coefficients were calculated from the time variation of the ion currents from the filaments, by using the Fick's law solution for impurity evaporation from a thin plate. By evaporating the solutes from the filaments at a series of temperatures, the temperature relations for the diffusion coefficients were found. There is evidence that the results obtained with this method are less subject to error than classical diffusion measurements, due to the fact that small, isolated diffusion samples are used. Also, the solute ion beams can be programmed in magnitude to achieve maximum accuracy and rapidity in diffusion measurements. At present, however, this new method is limited in the temperature range in which it may be successfully employed. (Disser. Abstr.)

41017 IMPROVEMENTS IN OR RELATING TO RADIAL EXTRUSION. Richards, John Dent; Wolley, Herbert William George. (to United Kingdom Atomic Energy Authority). British Patent 1,119,241. July 10, 1968. Filed Sept. 2, 1964.

A device for forming finned fuel cans by radial extrusion comprises split dies, heated by infrared radiation, and a mandrel to pull tubular stock through the die system. (P.G.C.)

41018 FIBERING OF OXIDES IN REFRACTORY METALS. Jech, R. W.; Weeton, J. W.; Signorelli, R. A. (Lewis Research Center, Cleveland). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ., No. 427, 91-106(1967).

From Symposium on Fiber-Strengthened Metallic Composites, Chicago. See CONF-661137.

An investigation of the fibering of oxides by hot deformation in metal matrices was carried out using unalloyed niobium or tantalum as the matrix material and thorium oxide, zirconium oxide, magnesium oxide, or aluminum oxide. Composites were prepared by conventional powder metallurgical techniques and extrusion. The composites were examined for microstructures and fiber length-to-diameter ratio and tested in tension at room temperature and 1100, 2200, 2500, 2750, and 3000°F. Stress-rupture tests were conducted on the composites at 2200 and 2500°F for lines up to 1000 hr. It was found that the oxides could be plastically de-

formed into fibers at temperatures well below their melting points when mechanically worked in a ductile matrix. Composites produced in this way exhibited improved tensile strengths and ratios of tensile strength to density as well as improved stress-rupture strength when compared to additive-free matrix materials and compared favorably with some commercial alloys. (auth)

41019 MECHANISM FOR THE PRESSURE-SINTERING (HOT PRESSING) OF BERYLLIUM. Butcher, J. W.; Lindsay, H. M.; Lowe, J. N.; Scott, V. D. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Powder Met., 11: 188-202(Spring 1968).

Previous work on the vacuum hot pressing of Be powders is reviewed to illustrate the dominant role of powder chemistry in consolidation behaviour. New electron-microscope evidence is advanced to show that oxides are present on the surface of Be powder particles but are not found predominantly at the grain boundaries of hot-pressed compacts. A model is proposed, incorporating the macro and micro features of consolidation, which involves sintering of the compact followed by recrystallization. (auth) (UK)

41020 ELECTRON BEAM WELDING OF COPPER TO MOLYBDENUM, TANTALUM, AND Kh18N10T STEEL. Terebikhin, G. V. Svar. Proizv., No. 10, 8-9(1967). (In Russian).

VM-2 molybdenum and TVCh tantalum sheets 0.5 mm thick were butt joined to M1 copper sheets by electron beam welding. Also, molybdenum rods, 14 mm in diameter, were lap joined at the ends to a copper bushing with a wall thickness of 1.5 mm slipped over them. The microhardness of molybdenum-copper joints in a fusion zone 0.03 mm wide gradually decreased from 286 kg/mm^2; the microhardness of molybdenum before welding decreased to 80 kg/mm^2, and at a distance of 0.1 mm from the joint was 90 kg/mm^2, i.e., equal to that of copper. (ATD)

41021 FIBER-STRENGTHENED METALLIC COMPOSITES. A Symposium Presented at the American Society for Metals 1966 Metals Congress, Chicago, Ill., November 2-3, 1966. Philadelphia, American Society for Testing and Materials, 1967. 184p. $12.75. (ASTM-STP-427; CONF-661137).

A total of nine papers was presented at the symposium. A separate abstract was prepared for each of five of these papers. Papers for which no abstracts were prepared are concerned with interior elastic stresses, properties of B-Ni composites, and fundamentals of metal matrix composites. (J.R.D.)

For abstracts of individual papers see: 41018, 41022, 41023, 41052, and 41053.

41022 HOW METAL MATRIX COMPOSITES ARE MADE. Davis, L. W. (Harvey Engineering Labs., Torrance, Calif.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ., No. 427, 69-90(1967).

From Symposium on Fiber-Strengthened Metallic Composites, Chicago. See CONF-661137.

In employing metal matrices, several methods have been used to achieve distribution of the reinforcement in the matrix. These include powder metallurgy, electrodeposition, plasma flame spraying, molten metal impregnation, and solid state diffusion bonding. Work at Harvey Engineering Laboratories has been concentrated on two methods, diffusion bonding for building up the matrix around continuous fibers and molten metal encapsulation with whiskers. Most of the work has been done in the development of an aluminum matrix composite with continuous fine steel wire as the reinforcing material. A number of compositions have been employed, but Type 355 stainless steel wire in 2024 aluminum alloy has had most use. Heat, pressure, plastic deformation, and coatings have been used in various combinations for effecting bonding of the steel wire in the aluminum matrix. Material from 0.040 in. thick up to 0.75 in. thick has been made. Plate as large as 1 ft. wide by 8 ft. long has been produced. Micro and macro structure and mechanical properties have been studied for various fabricating procedures and plate sizes. Tests have been conducted to determine the feasibility of incorporating brittle reinforcing materials such as beryllium and boron in the aluminum matrix. Composites can be produced without breakage of the reinforcing fiber. Work to date shows that continuous unidirectional fibers, the tensile strength and modulus of elasticity can be predicted on the basis of the properties of the components and the percentage of each in the composite. Representative applications for composites are cryogenic tankage, airframe and missile structural components, helicopter blades, and turbine engine compressor blades. Many other uses will develop as the properties of this class of materials become more fully characterized. (auth)

41023 HIGH ENERGY-RATE FORMING OF FIBROUS COMPOSITES. Robinson, R. K. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ., No. 427, 107-23(1967). (BNWL-SA-550(Rev.)).

From Symposium on Fiber-Strengthened Metallic Composites, Chicago. See CONF-661137.

Fabrication problems with metal matrix composite materials include compatibility of the matrix and reinforcement, retention of fiber alignment, and formation of intricate shapes or structures. Preliminary studies of seven composite systems were made at Battelle-Northwest using a pneumatic-mechanical high energy-rate forming process. Compatibility problems were reduced by the use of lower temperatures than those used in more conventional processes. Alignment retention appeared to be controllable by varying the impaction mold design to produce preferential axial, radial, or isostatic forces. The forming method was highly effective for the formation of complex monolithic structures such as turbine blades, honeycombs, and nozzles having internal cooling passages. (auth)

41024 FUEL ELEMENT FOR A WATER-COOLED NUCLEAR REACTOR. (to Aktiebolaget Atomenergi). French Patent 1,442,758. Filed July 21, 1965.

A fuel element is described comprising a body of metallic fuel, a metallic outer can consisting of Zr, Zr-alloy or stainless steel, and an inner can consisting of Al and Mg and their alloys, the inner can being provided with recessed portions remote from the fuel body and allowing an expansion of the body within the outer can without rupturing the latter. The recessed portions are either grooves in the surface of the inner can facing the outer can or canals extending longitudinally in the wall of the inner can. (NPO)

41025 ZIRCONIUM-BASED MATERIALS TO BE UTILISED IN NUCLEAR REACTORS. (to Siemens-Schuckertwerke Aktiengesellschaft). French Patent 1,448,044. Filed Apr. 9, 1965.

Zr-based materials, e.g., sheath, tubes or bars are described, which comprise at least two metallic layers, one consisting of a Zr-alloy, having a high mechanical resistance, e.g., Zr containing 1.25% Al, 1% Sn, and 1% Mo, and the other consisting of a Zr-alloy, having a high corrosion resistance, e.g., Zr containing 2.5% Nb and 0.5% Cu or 0.5% Mo and 0.5% Cu, and an intermediate layer, consisting of a material which prevents or at least restricts the diffusion of H_2, e.g., an oxide, preferably ZrO_2. (NPO)

41026 METAL MIXING DURING ELECTRON BEAM WELDING. Shahinian, P.; Atwell, J. T.; Brooks, E. J. (Naval Research Lab., Washington, D. C.). Electrochem. Technol., 6: 282-6(July-Aug. 1968).

Welds made by the electron beam method were analyzed for information on the flow and distribution of metal during the fusion process. Wire inserts of copper, nickel, and niobium were used as tracers in titanium plate and the concentration and distribution of these in the fusion zone were determined. The direction and degree of transport of metal during the electron beam welding process were indicated by the post weld analyses. In general, mixing occurred; the presence of the added metal was found throughout the weld, but the concentration was not uniform. (auth)

41027 PRODUCING MOLYBDENUM POWDER IN A TUBULAR ROTATING FURNACE. Dhak'rov, Dimit'r; Visarionov, Vasil; V'lchev, Khristo; Khristov, Georgi. Rubodobiv Met. (Sofia), 22: 57-60(Sept. 1967). (In Bulgarian).

A new and improved method of producing Mo powder in a tubular rotating furnace is described and the results of initial tests with this method are presented. Local Mo concentrate is employed in the furnace. The production method is based on a continuous principle with the progressive reduction of the original paramolybdate as the material passes through the furnace. The final product is a moderately fine Mo powder of excellent quality for the requirements of contemporary powder metallurgy. (auth)

41028 MACHINING OF NUCLEAR MATERIALS. Wright, W. J. Prod. Eng., 46: 638-50(Nov. 1967).

The machining behavior of U, Th, Pu, Be, and Zr as metal and oxide, is discussed. Hazards encountered in the machining of nuclear materials are classified as radioactivity, toxicity, and pyrophoricity. Handling and safety procedures to deal with these hazards are outlined. Typical machining conditions for turning, milling, and drilling U, Th, Be, Zr, and U, are shown. The conditions are indicative of feed, speed, depth of cut, and tool. Some consequences of machining are illustrated, showing examples of how machining can alter the surface structure of the material. Machined Zr surfaces corrode more rapidly than etched or annealed surfaces. The strength of Be metal in the as-machined state may be 30 to 40% lower than in etched or annealed material. (auth)

41029 ZIRCONIUM ROUTE BYPASSES SPONGE STEP. Can. Chem. Process., 69-72(June 1968).

Existing production methods for Zr are reviewed. The process proposed at Eldorado Nuclear Ltd. $8.3 million plant converts zircon sand to zirconyl nitrate, purifies it by solvent extraction

and reduces the fluoride directly to Zr alloys. The large amount of Zircaloy-2 required in the Canadian reactor program and better utilization of scrap provide incentives for this improved process. (F.S.A.)

Properties Evaluations

Refer also to abstracts 40320, 41066, 42344, 42384, 42428, and 42575.

41030 (AGN-8279) EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING. Quarterly Progress Report, January 1–March 31, 1968. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). May 1968. Contract AT(04-3)-368. 34p. Dep. CFSTI.

The characterization of the metallurgical structure and oxidation behavior of Hastelloy X aged for various durations continues. Uniaxial creep tests at 1300°F in argon were terminated after 2530 hours. A centrifugal creep testing of specimens of three heats of Hastelloy X at 1400°F in high purity argon was terminated after 2232 hours. The 1400°F test data were used as the basis for the design of specimens for a 1300°F centrifugal creep test. The centrifugal creep specimens tested at 1400°F were examined metallographically to identify microstructural changes. The specimens were also digested chemically and the remaining particles identified by x-ray techniques. Differences in structure were observed between stressed (centrifugal creep) specimens and statically aged specimens. These structural changes are, to a major degree, influenced by the stress present in centrifugal creep specimens. Microhardness measurements were made on centrifugal creep specimens tested at 1300 and 1400°F. Significant increases in hardness were observed in all specimens. Activation energies were calculated for one heat of Hastelloy X material at two stress levels; the activation energy in the 1725 to 1785 psi range is 60200 cal/mole and in the 1288 to 1372 psi range is 88948 cal/mole. (J.C.W.)

41031 (AI-AEC-12671) SOLUBILITY OF COPPER IN SODIUM. Eichelberger, R. L.; McKisson, R. L. (Atomics International, Canoga Park, Calif.). May 31, 1968. Contract AT(04-3)-701. 22p. Dep. CFSTI.

The solubility of copper in sodium has been studied in the temperature range of 250 to 726°C, using a very high purity sodium and oxygen free high conductivity (OFHC) copper. A capsule technique was used for the experiments, with the sodium exposed only to high vacuum. Chemical analysis was performed using colorimetry and atomic absorption spectrometry. Results of the 21 experiments reported between 350 and 726°C were combined with those from two other studies to give the expression $\log_{10}S(\text{ppM Cu in Na}) = 5.957 - 3430/T(°K)$, based on 39 data points and covering the temperature range of 245 to 726°C. (auth)

41032 (AI-AEC-12694) BIAXIAL STRESS-RUPTURE PROPERTIES OF AUSTENITIC STAINLESS STEELS IN STATIC SODIUM. Lee, W. T. (Atomics International, Canoga Park, Calif.). June 30, 1968. Contract AT(04-3)-701. 52p. Dep. CFSTI.

The stress-rupture characteristics of austenitic stainless steels in a liquid sodium environment were investigated in both cold-worked and annealed conditions. Results of the following biaxial (2 : 1) stress-rupture tests in high-purity ($O_2 \sim 10$ ppM) sodium are presented: (1) 10 to 15% cold-worked Type 304 stainless steel tested at 1000, 1100, 1200, and 1400°F for periods up to 4000 hr; (2) annealed Type 304 stainless steel tested at 1200 and 1400°F for periods up to 2000 hr; (3) 10 to 15% cold-worked Type 316 stainless steel tested at 1000, 1200, and 1400°F for periods up to 4000 hr; and (4) annealed Type 316 stainless steel tested at 1200 and 1400°F for periods up to 3000 hr. For both austenitic stainless steels, the short-term rupture strength, rupture life, and diametral strain of thin-walled tubing in an environment of high-purity sodium were unchanged from results obtained when tested in an atmosphere of high-purity helium. High-purity liquid sodium exhibits the same lack of effect on 10 to 15% cold-worked and annealed austenitic stainless steels. Cold-worked austenitic stainless steel tubing, in comparison with annealed material, was found to have lower long-term rupture strength, when tested at temperatures where recovery processes are operative. Cold work also reduced diametral strain. The formation of sigma phase was detected and is attributed largely to cold work and creep deformation. In comparison with the rupture strength of 10 to 15% cold-worked Type 304 stainless steel tested at 1400 and 1200°F, 10 to 15% cold-worked Type 316 stainless steel was found to possess significantly higher long-term rupture strength and comparable ductility (diametral strain). (auth)

41033 (KAPL-P-3439) FATIGUE-CRACK GROWTH RATE STUDIES OF LOW ALLOY PRESSURE-VESSEL STEELS. Mowbray, D. F.; Andrews, W. R.; Brothers, A. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 1968. Contract W-31-109-eng-52. 29p. (CONF-680904-1). Dep. CFSTI.

From Conference on the ASME Pressure Vessels, Piping and Petroleum Division, Dallas, Tex.

Fatigue-crack growth rates were determined at room temperature for ASTM A302–Class B and A508–Class 2 steels in two characteristic plate and forging directions. Tests were performed under zero-to-tension cyclic loading using both through-crack and part-through-crack plate specimens. Crack growth rates in the through-crack specimens, though affected by plate or forging directions, were found to correlate well upon the hypothesis that the crack extension per cycle is proportional to a positive power of the range of alternating stress intensity factor. In addition, the rate of crack extension through the plate thickness of the surface-crack specimens was successfully correlated with data from through-crack specimens. (auth)

41034 (MIT-3635-2) MECHANICAL PROPERTIES OF METALS AT LOW TEMPERATURES. (Massachusetts Inst. of Tech., Cambridge). Aug. 1967. Contract AT(30-1)-3635. 5p. DTIE.

Shear fracture in the deformation of Zr alloys is discussed. Progress during the past year included: The grain size of Zircaloy 4 was increased using a heat treatment. Large single Zr crystals were grown. In the uniaxial and plane strain compression testing of Zircaloy-4 at room temperature, texture was found to develop in the shear at smaller strains in plane-strain compression. Fracture at ~15% reduction was initiated in the elastic-plastic transition zone and propagated transgranularly through intense shear bands oriented 45° to the applied stress axis. (D.L.C.)

41035 DEVELOPMENT OF PREFERRED ORIENTATIONS IN COLD-ROLLED NIOBIUM (COLUMBIUM). Vandermeer, R. A.; Ogle, J. C. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Trans. Met. Soc. AIME, 242: 1317-26(July 1968). (ORNL-P-3593).

The preferred crystallographic orientations (texture) developed in randomly oriented, polycrystalline niobium during rolling were studied by means of x-ray diffraction techniques. The evolution of texture at both the surface and center regions of the rolled strip was carefully examined as a function of increasing deformation throughout the range 43 to 99.5% reduction in thickness. Certain aspects of the center texture development in niobium are in agreement with the predictions of a theory by Dillamore and Roberts, but others cannot be explained by the theory in its present form. Above 87% reduction by rolling, a distinctly different texture appeared in the surface layers which was unlike the center texture. The present results are compared with previous results obtained from other bcc metals and alloys. (auth)

41036 DUCTILE-BRITTLE-DUCTILE TRANSITION IN NIOBIUM–HYDROGEN ALLOYS. Oakwood, T. G.; Daniels, R. D. (Univ. of Oklahoma, Norman). Trans. Met. Soc. AIME, 242: 1327-33(July 1968).

A study was made of the effects of small quantities of hydrogen on the mechanical properties of niobium. Tensile specimens, hydrogenated to concentrations of 20 to 200 ppM, were tested at temperatures of 300, 191, and 77°K. Although hydrogen was found to have little effect on the strength of niobium, the ductility of Nb–H alloys was found to be quite sensitive to both hydrogen concentration and temperature. At 300°K, an abrupt loss in ductility occurred at a critical hydrogen concentration, although some ductility was observed beyond the tolerance limit. A similar result was found at a lower hydrogen concentration at 191°K. At 77°K, however, a more gradual loss in ductility with increasing hydrogen concentration was observed. Hydrogenated niobium was thus observed to undergo a ductile-brittle-ductile transition. Metallographic examination of fractured specimens revealed extensive porosity at both 77 and 300°K which was a distinct function of hydrogen content. At 191°K, although some secondary cracking was noted, the amount of observed porosity was minimal. These observations are interpreted in terms of hydrogen solubility and mobility as a function of temperature and in the role of hydrogen in promoting growth of microcracks. (auth)

41037 CRYSTALLINE STARK SPLITTING IN $TmAl_3$. Buschow, K. H. J. (Philips Research Labs., Eindhoven, Netherlands). Z. Phys. Chem. (Frankfurt), 59: 21-6(May 1968).

Results of magnetic measurements on the intermetallic compound $TmAl_3$ between 4.2 and 700°K in various magnetic fields are presented and analyzed with the help of the cubic crystal field potential. It is shown that the abnormal behavior of this compound at low temperatures can be explained by a crystal field splitting of the ground state of Tm^{3+} ions. (M.C.G.)

41038 COLUMBIUM [NIOBIUM] 10W–10Hf: (HIGH TEMPERATURE ALLOY). Alloy Dig., Cb-13, 2p(Oct. 1967).

Niobium–10W–10Hf is a Nb-base alloy with good oxidation resistance, recommended for high-temperature applications such as missiles and space vehicles. The recrystallization temperature range is 1900 to 2200°F. The ductile-to-brittle transition temperature is less than −320°F for the fibered condition, −275°F for the recrystallized (2400°F) condition, and −200°F for the recrystallized (2800°F) condition. It can be satisfactorily welded using chamber welding techniques with Ar atmosphere. (J.R.D.)

41039 TENSILE EVALUATION OF UNWORKED TUNGSTEN–25 PERCENT RHENIUM ALLOYS CONSOLIDATED BY SINTERING ELEMENTAL POWDERS. Milner, Alan (3M Co., St. Paul, Minn.). Contract AT(11-1)-1518. Powder Met., 11: 56-62 (Spring 1968).

The use of refractory metals in the as-sintered condition has been precluded by the belief that useful engineering properties cannot be obtained in the unwrought alloys. A comparison of tensile data for commercial wrought W–25% Re rod in the recrystallized condition and unwrought as-sintered rod directly converted from elemental powders is presented, to show that at comparable grain size there need be no marked difference in properties. After exposure to very high temperatures the sintered material is markedly superior to the wrought recrystallized alloy as a result of the differences in grain-growth characteristics. (auth)

41040 WASPALOY: HIGH TEMPERATURE ALLOY. Alloy Dig., Ni-129, 2p(Nov. 1967).

Waspaloy is a vacuum induction melted Ni-base alloy (12–15% Co, 3.5–5% Mo, 2.6–3.25% Ti, 1–1.6% Al, 18–21% Cr, 2% maximum Fe, 0.10% maximum C) with outstanding tensile and stress-rupture strength up to 1400°F, combined with high oxidation resistance up to 1600°F. It is strengthened by precipitation hardening. It is recommended for gas turbine engines, airframe assemblies and missile systems. (auth)

41041 ON THE DUCTILITY OF SAP ALLOYS. Schiller, P.; Schneiders, A. (CCR-EURATOM, Ispra, Italy). J. Nucl. Mater., 27: 115-17(July 1968).

A new fabrication technique is developed to improve high temperature ductility of SAP. An Al/Al_2O_3 dispersion-hardened alloy (Microxal) with particles of a diameter in the range of 30 to 200 Å is produced. Data are presented that show the finer dispersion of aluminum oxide in the aluminum matrix brings at high temperatures an improvement with respect to ordinary SAP. Strength and ductility are higher. (J.C.W.)

41042 EFFECT OF HYDROGEN AND EXTENSION RATES ON THE MECHANICAL PROPERTIES OF Zr–1 PERCENT Nb ALLOY OVER THE TEMPERATURE RANGE 30 TO 600°C. El-Shanshoury, I. A.; Voronin, I. M.; Bassim, M. N.; Rudenko, V. A. (Atomic Energy Establishment, Cairo). J. Nucl. Mater., 27: 102-7(July 1968).

The presence of hydrogen in the Zr–1% Nb alloy is observed to increase ultimate tensile strength and decrease the strain in the overall range of temperature 30 to 600°C. These changes in the mechanical properties depend on the amount of hydrogen in the specimens. A drop in the ductility of the Zr–1% Nb alloy was found between 250 and 400°C for an extension rate of 2.5 mm/min. The addition of hydrogen caused a pronounced decrease in the ductility in this temperature range. The temperature at which Zr–1% Nb alloy loses its ductility falls with a decrease in extension rate. A shift of about 100°C is obtained with a change in the extension rates from 80 to 2.5 mm/min. (J.C.W.)

41043 HEAT CONTENTS AND SPECIFIC HEATS OF SOME URANIUM-BEARING FUELS. Farkas, M. M.; Eldridge, E. (Battelle Memorial Inst., Columbus, Ohio). J. Nucl. Mater., 27: 94-6(July 1968).

Specific heat data for Nb–20 wt % U, U–10 wt % Mo, and UBe_{13} were obtained. Sample preparation methods are described and specific heat measurement results at various temperatures are tabulated. (J.C.W.)

41044 DISSOLUTION KINETICS OF HYDRIDE PLATELETS IN ZIRCALOY-4. Kearns, J. J. (Bettis Atomic Power Lab., West Miflin, Pa.). Contract AT(11-1)-Gen-14. J. Nucl. Mater., 27: 64-72(July 1968). (WAPD-T-2030).

The rate of dissolution of dispersed hydride platelets has been examined in Zircaloy-4 samples containing 60, 114, and 205 ppM hydrogen. Observed rates were very high and agreed well with diffusion calculations. The diffusion-controlled kinetics are shown to depend on hydrogen concentration, hydride thickness, diffusivity and terminal solubility of hydrogen in the alpha phase. Equations are derived which show the relationships among these parameters. (auth)

41045 HIGH TEMPERATURE CREEP PROPERTIES OF COMPACTED MAGNESIUM POWDER. Vickers, W.; Greenfield, P. (English Electric Co. Ltd., Whetstone, Eng.). J. Nucl. Mater., 27: 73-9(July 1968).

High temperature creep tests have been conducted on compacted magnesium powder containing 1% oxygen. The results show that the material is stronger in creep than any other known magnesium alloy. Both the activation energy and the stress exponent are very high and these are discussed in terms of possible mechanisms of creep. (auth)

41046 FIELD EMISSION MICROSCOPIC OBSERVATION OF THE ADSORPTION OF OXYGEN, NITROGEN, HYDROGEN, CARBON MONOXIDE, AND XENON ON RHENIUM. Ishizuka, Kazuhiko (Hokkaido Univ., Sapporo). J. Res. Inst. Catal., Hokkaido Univ., 15: 95-110(Dec. 1967).

The behavior of adsorbed oxygen, nitrogen, hydrogen, carbon monoxide, and xenon on rhenium were observed with a field-emission microscope. At 77°K changes in the emission patterns and average work function of rhenium resulting from the adsorption of these gases were observed, and by raising temperature stepwise up to 2000°K their subsequent changes due to desorption (or surface reaction) were pursued. Oxygen adsorption at $\sim 10^{-9}$ mmHg darkened the $(11\bar{2}3)$ and $(11\bar{2}1)$ regions of rhenium. On heating up to 800 to 1300°K most of oxygen was removed from the surface and the pattern changed drastically to give a buildup pattern. Above 1400°K the emitting regions gradually broadened out, and finally at 2000°K a pattern regarded as that of clean rhenium was obtained. Nitrogen, hydrogen, carbon monoxide, and xenon adsorptions resulted in a pattern insensitive to surface topography, that with relatively bright arcs and ovals bounded by the $[1\bar{2}10]$, $[1\bar{1}00]$, $[11\bar{2}3]$ zone lines, that of a mottled appearance, and that with prominently bright regions along the $[1\bar{1}00]$ zone, respectively. Adsorbed xenon, hydrogen, nitrogen, and carbon monoxide were thoroughly removed by raising temperature up to room temperature, 900, 1000, and 1100°K, respectively, although even at 77°K xenon was partially removed by evacuating down to 2×10^{-9} mm Hg. The increase in the average work function of rhenium caused by the adsorption of oxygen, nitrogen, hydrogen, carbon monoxide, or xenon was 1.9, −0.41, 0.55, 0.72, or −1.1 eV, respectively, at 77°K. (auth)

41047 PHASE DIAGRAM, COMPRESSIBILITY AND RESISTANCE OF AMERICIUM AS A FUNCTION OF PRESSURE. Stephens, D. R.; Stromberg, H. D.; Lilley, E. M. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Phys. Chem. Solids, 29: 815-21(May 1968). (UCRL-70623).

The compressibility at room temperature and the pressure-temperature phase diagram of americium were determined to 35 kbar, and the electrical resistance at room temperature was measured to 120 kbar. Americium exhibited a higher compressibility than other actinides; in general, the physical properties of americium resembled rare earths more closely than the other actinides. The melting curve of americium obeyed the Kraut and Kennedy (1966) melting relation. Details of the phase diagram were in good agreement with recent work of Wade and Wolf (1967). The melting point at 1 atm is 1173°C. There was an anomaly in the curve of resistance vs. pressure at 90 kbar; this effect may be due to a phase transition. (auth) (UK)

41048 LOW TEMPERATURE SPECIFIC HEAT OF B. C. C. TITANIUM–MOLYBDENUM ALLOYS. Sinha, A. K. (Univ. of Illinois, Urbana). J. Phys. Chem. Solids, 29: 749-54(May 1968).

Low-temperature specific heat measurements in the range from 1.4 to 4.2°K were made for bcc Ti–Mo alloys. The γ vs. e/a plot shows a maximum at e/a = 4.4 and a shallow minimum at e/a = 5.75. These results are considered in the light of the average band behavior as derived from pure 3d and 4d bands. The superconducting electronic specific heat data are in accord with the BCS theory and fit the equation $C_{es}/\gamma T_c = 10.71 \exp(-1.59 T_c/T)$. The interaction parameter V is nearly constant at 0.165. The minimum in the Debye Temperature θ_D vs. e/a curve corresponds to the maximum in the density of states at about the same electron concentration. (auth) (UK)

41049 ELECTRONIC SPECIFIC HEAT OF IRON-BASED DILUTE ALLOYS. Shinozaki, Samuel S. (Ford Motor Co., Dearborn, Mich.). Trans. Jap. Inst. Metals, 9: 82-8(Apr. 1968).

The change in the electronic specific heat of dilute alloys, especially iron with a small addition of solute elements, was investigated experimentally in order to understand the electronic band structure of transition elements in relation to the origin of ferromagnetism. Since a small change (order of one or two percent) in the electronic specific heat with a small addition of the solute element has to be measured, a special calorimeter, which is used to measure simultaneously the specific heat of three samples, one pure metal and two alloys, has been developed for this purpose. Using this calorimeter, the change of γ can be measured with a higher accuracy of one order of magnitude. The solute elements for iron-based alloys are: Ti, V, Cr, Mn, Co,

Ni, Nb, Mo, W, Si, and Al. Silver-based alloys with gold are also measured to check the accuracy of this calorimeter. The variation of γ for Ag(Au) alloys is less than experimental uncertainty, while the variation of the Debye temperature shows a linear decrease with gold concentration. For iron-based alloys, out of the eleven solutes, six decrease the γ values linearly with solute concentration, c. Their values of $(1/\gamma)\Delta\gamma/\Delta c$ are: Fe(Ti), −1.0; Fe(V), −2.2; Fe(Cr), −2.0; Fe(Co), −0.6; Fe(Mo), −0.8; and Fe(W), −2.4. Four solutes increase the γ values nonlinearly with respect to the solute concentration. The average values of $(1/\gamma)\Delta\gamma/\Delta c$ near c = 0 are: Fe(Al), +1.2; Fe(Si), +0.6; Fe(Mn), +2.0; and Fe(Ni), +2.6. These data are utilized to discuss the applicability of the rigid band model as well as to correlate the changes with those of magnetic properties. (auth)

41050 DIFFUSION OF URANIUM IN ALUMINUM AT INFINITE DILUTION. Blechet, J. J.; Van Craeynest, A.; Calais, D. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 27: 112-13(July 1968). (In French).

The diffusion of uranium in aluminum at infinite dilution was measured using the method of a thin film of uranium vapor deposited on the surface of a thick aluminum sample. The samples were exposed to a neutron flux of the order of 3×10^{16} n/cm^2. No intergranular diffusion was detected between 500 and 625°C. The coefficient of diffusion D is between 10^{-8} and 10^{-9} cm^2/sec. The values are tabulated. The activation energy is Q = 28,000$\pm^{6000}_{4000}$ cal. (tr-auth)

41051 DIFFUSION AND SOLUBILITY OF PLUTONIUM IN ALUMINUM. Housseau, N.; Van Craeynest, A.; Calais, M. D. (CEN-FAR, Fontenay-aux-Roses, France). J. Nucl. Mater., 27: 114(Julv 1968). (In French).

The solubility of plutonium in aluminum was determined by x-microanalysis of an Al−Pu alloy with 1.7 at.% Pu. At 630°C, $600 \pm 300 \times 10^{-6}$ and, at 595°C, $500 \pm 200 \times 10^{-6}$ in weight were the solubility values obtained. The diffusion coefficients were then measured by the Jost method, but the imprecisions were significant. The imprecisions came from the coalescence of precipitants during annealing. New measurements of the diffusion coefficients were made using the Matano method. The results showed that the diffusion in homogeneous phase is quite different from that in polyphase systems. This seems to indicate that the dissolution of Pu−Al precipitants has a significant influence on the diffusion kinetics in polyphase systems. (J.S.R.)

41052 ANALYSIS OF STRESS-RUPTURE AND CREEP PROPERTIES OF TUNGSTEN FIBER REINFORCED COPPER COMPOSITES. McDanels, D. L.; Signorelli, R. A.; Weeton, J. W. (Lewis Research Center, Cleveland). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ., No. 427, 124-48(1967).

From Symposium on Fiber-Strengthened Metallic Composites, Chicago. See CONF-661137.

An analysis of the creep deformation of fiber reinforced metallic composites was developed. Equations for predicting the creep rate and stress-rupture properties of fiber reinforced metallic composites are presented. Stress-rupture and creep tests were conducted at 1200 and 1500°F on tungsten fiber reinforced copper composites. The results of these tests were used to verify the validity of the equations developed in the analysis. A discussion was presented relating the results obtained with the model system to more practical fiber reinforced composite systems for stress-rupture applications. The stress-rupture strengths obtained with the tungsten-copper model system compared favorably with those of existing superalloys and demonstrated the potential of fiber reinforced metallic composites in stress-rupture applications at elevated temperatures. (auth)

41053 METALLURGICAL AND GEOMETRICAL FACTORS AFFECTING ELEVATED TEMPERATURE TENSILE PROPERTIES OF DISCONTINUOUS TUNGSTEN FIBER REINFORCED COMPOSITES. Petrasek, D. W.; Signorelli, R. A.; Weeton, J. W. (Lewis Research Center, Cleveland). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ., No. 427, 149-75(1967).

The length to diameter ratio and orientation of the fibers in discontinuous fiber reinforced composites was correlated to their elevated temperature tensile properties. Composites were made of copper and copper−2% chromium alloy reinforced with tungsten fibers having various length to diameter ratios. The composites were tested in tension at 300, 900, and 1500°F. These results were then compared with continuous length fiber reinforced composites containing the same matrix materials and fiber contents. The fiber orientation in the composite was found to be extremely critical at elevated temperatures. Shear failures occurred for specimens tested at 1500°F in which the fibers were misaligned from the tensile axis by as small as 3°. Composites which failed in shear had significantly lower tensile strengths than did composites having fibers aligned parallel to the tensile axis of the specimen. Tensile strengths of discontinuous fiber reinforced composites in which the fibers were aligned parallel to the tensile axis were dependent upon the length to diameter ratio of the fibers in the composite. As the length to diameter ratio of the reinforcing fibers decreased, the tensile strengths of the composites decreased. Alloying the copper matrix with chromium increased the matrix shear strength which was beneficial even though the alloying element reacted with the fiber. Load transfer from the matrix to the fiber was dependent upon the shear strength of the matrix. The greater the shear strength, the higher the load transfer capabilities of the matrix. The tensile strength of copper−2% chromium matrix composites thus was higher than unalloyed copper matrix composites having the same fiber content and the same length to diameter ratio fibers. (auth)

41054 MECHANISM OF STRENGTHENING OF MOLYBDENUM-BASE ALLOYS CONTAINING Ti, Zr, AND Hf ADDITIONS. Semchyshen, Marion. Detroit, Wayne State Univ., 1963. 167p.

Thesis.

It was previously known that vacuum-melted molybdenum-base alloys containing relatively small amounts of titanium and zirconium exhibited elevated temperature strengths appreciably higher than those predicted on the basis of purely solid solution hardening. The mechanism that contributed to the disproportionately high strength of these alloys was investigated. The alloys for this investigation were all vacuum-arc-cast, and contained up to 5% Ti, 0.5% Zr or 1% Hf, as well as a combination of 1.25% Ti + 0.3% Zr. In addition to the principal alloy additions, the materials contained variations in the amount of oxygen, carbon, and boron present. The cast alloys were worked to bar stock by extrusion and subsequent rolling. The wrought bar stock was evaluated in terms of resistance to recrystallization, tensile properties in the strain hardened and recrystallized conditions at room and elevated temperatures, and creep-rupture properties in the range 1600 to 2400°F for stress-relieved and recrystallized materials. Metallographic and x-ray diffraction studies identified the character and morphology of the phases present. The investigation conclusively proved that the high recrystallization temperatures and high elevated temperature strengths of vacuum-melted molybdenum-base alloys containing relatively small amounts of titanium, zirconium or hafnium are dependent upon the carbon content of the alloy. Carbon contents in excess of 100 ppM in the alloys under investigation caused an increase in the strain hardening coefficient, recrystallization temperature, tensile strengths and creep-rupture strength. The mechanism by which carbon brings about the beneficial attributes to these alloys is based on the formation of fine dispersions of TiC, ZrC or HfC, as the case may be. The dispersed precipitates effect improved metallurgical and mechanical properties by impeding dislocation movement and climb. The optimum carbon contents from the standpoint of elevated temperature strength for Mo−Ti and Mo−Zr alloys are equal to one-tenth the titanium content and two-tenths the zirconium content, respectively. In the case of Mo−Hf alloys, the optimum C/Hf ratio is within the range 0.5 to 1.0. For alloys containing both titanium and zirconium, a carbon content calculated on the assumption of additive effects appears applicable. It is demonstrated that increasing the carbon content beyond the optimum ratio does not improve strength properties, but does tend to decrease ductility. Boron additions are shown to increase strength and recrystallization properties of molybdenum-base alloys. Boron is not, however, as effective as carbon on these counts. The metallurgical and mechanical behavior of molybdenum-base alloys was insensitive to oxygen content within the range that is possible to achieve in the vacuum-arc-melting process. A prophesy of future widespread usage and acceptance of certain of the more complex molybdenum-base alloys is made. The basis for this contention is the amenability of these materials to heat treatment. The ability to more than double elevated temperature strength by the judicious selection of solution and aging treatments is cited. (Disser. Abstr.)

41055 LOW TEMPERATURE TRANSIENT CREEP OF SELECTED BODY-CENTERED CUBIC METALS AND BINARY SOLID SOLUTION ALLOYS. Jackman, Laurence Arthur. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 259p.

Thesis.

The mechanism controlling thermally activated deformation in body-centered cubic materials has been investigated by determining the magnitude and behavior of the activation energy and the activation volume associated with the transient creep of selected body-centered cubic metals and binary solid solution alloys at 77 to 453°K. The phenomenon of creep has been chosen in preference to other manifestations of thermally activated deformation because it affords the most direct and accurate means of evaluating the activation parameters. Experiments were performed on a constant stress creep machine designed and constructed specifically for this investigation. Niobium, vanadium, tantalum, Nb−V alloys and Nb−Ta alloys were utilized to eliminate the possibility of valence

effects and to isolate any size factor effects from effects related to a change in the shear modulus. This was possible because all three metals have the same valence, because Nb and Ta have about the same atomic radius, and because the shear modulus of V is between those of Nb and Ta. The activation energy and activation volume were determined from incremental changes in the temperature and stress, respectively. Both the activation energy and the activation volume were determined to be independent of strain, temperature, and strain rate, but were strongly dependent on the effective stress. Also, they appeared to be insensitive to the lattice parameter and proportional to the shear modulus. The mechanism governing the deformation process in the pure metals was also rate-controlling in the solid solution alloys and either was not perturbed by the presence of substitutional solute atoms or was perturbed very slightly through the atomic size factor. Because the activation energy and volume were very sensitive to the effective stress, accurate techniques were devised to determine the effective stress. The experimental results are in good agreement with the mechanism of overcoming the Peierls'-Nabarro stress barrier by the formation and subsequent lateral propagation of double kinks. Kink energies, activation energies, and the effective stress dependence of the activation volumes and the activation energies calculated using the Seeger and Dorn-Rajnak models for this mechanism agree favorably but not completely with the experimental data. Critical distances of separation between the two kinks comprising a double kink at the configuration corresponding to the state of maximum energy calculated from the experimental activation volumes are consistent with this mechanism. A delayed creep phenomenon was observed at temperatures of 373°K and above for each of the materials included. The experimental observations of this phenomenon suggest that the role of interstitials in the yield point behavior characteristic of body-centered cubic metals is to control the rate at which dislocations move away from dislocation sources, while the subsequent generation of new sources is responsible for the drop in stress at the yield point. Tensile tests were performed to provide an estimate of the Peierls'-Nabarro stress. (Disser. Abstr.)

41056 GRAIN BOUNDARY PENETRATION OF NIOBIUM BY LITHIUM. Brehm, William Frederick Jr. Ithaca, N. Y., Cornell Univ., 1967. 122p. Thesis.

The penetration of lithium into the grain boundaries of oriented, oxygen-doped niobium bicrystals was studied as a function of time, temperature, oxygen doping level, and grain boundary structure. Oriented bicrystals of niobium containing a simple tilt boundary, a ⟨100⟩ rotated about a common ⟨110⟩, were grown by arc-zone melting oriented single crystals. Oxygen was added by anodically depositing Nb_2O_5 on the bicrystal surface and homogenizing by vacuum annealing. Specimens cut from the oxidized bicrystals were tested in liquid lithium in sealed capsules. Three different grain boundary angles, 6, 16, and 33°, were studied at oxygen levels of up to 2400 parts per million by weight. Most of the quantitative data were obtained from 16° crystals at 800 to 1050°C. The tests showed that the undoped niobium did not react with the lithium. The 6° crystals containing oxygen were corroded at the specimen surfaces but not preferentially in the grain boundaries. The 16 and 33° specimens containing oxygen were corroded at the specimen surfaces and preferentially in the grain boundaries. The depth of grain boundary penetration increased as $(time)^{1/2}$, and the rate constant k for the process defined by x(depth of penetration) = $(kt)^{1/2}$ had an activation energy of about 70 kcal/mole. The rate constant increased with increasing oxygen doping level, and was anisotropic; the penetration rate parallel to the common ⟨110⟩ was larger than the rate perpendicular to it. The kinetics, the anisotropy, and the high activation energy suggest a corrosion process controlled by solid-state grain boundary diffusion. A quantitative model has been developed to describe the penetration process. (Diss. Abstr.)

41057 REFRACTORY METALS (Cb, Ta, Mo, W). Van Orsdel, J.; Maykuth, D. J.; Barth, V. D. (Battelle Memorial Inst., Columbus, Ohio). DMIC Rev., 3p(July 5, 1968).

The properties of niobium alloys for reactor core and cladding materials are discussed. Structural and heat-shield panels fabricated from tantalum alloys are described. Long-time creep testing on molybdenum- and tantalum-base alloys at elevated temperatures continues. Niobium and tantalum alloys fabricated for the containment of alkali-metal working fluids for space power generators were tested and molybdenum alloys fabricated for alkali-metal-vapor turbine wheel and blade applications were tested. The properties of tungsten for nuclear space applications are summarized. (J.C.W.)

41058 INCREASE IN OVALITY OF URANIUM TUBES DUE TO CREEP UNDER EXTERNAL PRESSURE. Blackburn, W. S.; Percy, J. (International Research and Development Co., Ltd., Newcastle-upon-Tyne, Eng.). J. Strain Anal., 3: 226-31(July 1968).

The increase in ellipticity of a concentric slightly elliptical tube was theoretically investigated for the case of external pressure and radial temperature gradient when the creep rate is proportional to the stress and the constant of proportionality varies slightly between the principal axes. The presence of a radial temperature gradient accelerates the increase in ovality due to initial ovality on the outer surface and that due to circumferential variation of strength (except after very small collapses) and decreases that due to initial inner ovality. Further allowance for circumferential variation in temperature, due to an insulated inner surface and to a uniform heat-transfer coefficient to a gas at constant temperature around the outer surface, reduces the increase in all cases. (auth) (UK)

41059 INVESTIGATION OF THE WELDING OF ZIRCONIUM ALLOYS. Rev. Soudure, 23: 86-103(1967). (In French).

An exploratory study was made of welding methods for use in assembling Zircaloy 2 and Zircaloy 4 components for nuclear reactors and equipment for the chemical industry. Trials were made of resistance welding (spot welding of sheets and butt welding of end plugs to thin-walled tubes), inert gas-shielded arc welding (manual for sheets and automatic and manual for sheets and tubes), electron beam welding of tubes and sheets, and plasma arc welding of plugs to tubes. Information is given on surface preparation and other measures adopted to insure surgical cleanliness, optimum welding conditions, welding machines, and tooling and many other facets of procedure and equipment adopted to obtain satisfactory welds. Results of quality control are represented by data on mechanical properties, structure and corrosion resistance of joints, and heat affected zones. With the exception of plasma arc welding, which was the subject of minimum study, procedures were devised with all the other techniques for obtaining satisfactory welds on these two alloys. Inert gas shielded welding and electron beam welding meet the requirements for reactor applications, including fabrication of fuel element cases. (Rev. Metal Lit.)

41060 YIELDING AND WORK-HARDENING IN Ni–ThO_2 ALLOYS. Ashall, D. W.; Evans, P. E. (Univ. of Manchester, Eng.). Metal Sci. J., 2: 96-9(May 1968).

Theories of dispersion phase strengthening are briefly discussed and critically examined in the light of experimental evidence obtained with Ni containing a fine dispersion of ThO_2. The results are in close agreement with Orowan's theory. The work-hardening theory of Fisher, Hart, and Pry, though in qualitative agreement with the experimental results, postulates the formation of concentric dislocation loops around particles of the dispersed phase. Transmission electron micrographs of the Ni–ThO_2 indicate that the formation of prismatic loops near to particles is a more likely process, and this is borne out by analysis of the experimental results. (auth) (UK)

41061 MAGNETIC CHARACTERISTICS OF $Pr_zY_{1-z}Ni_2$ ALLOYS AND THE NATURE OF $PrNi_2$ AT LOW TEMPERATURES. Wallace, W. E.; Mader, K. H. (Univ. of Pittsburgh). Inorg. Chem., 7: 1627-9(Aug. 1968).

Magnetic characteristics are reported for $PrNi_2$ and a series of ternary alloys represented by the formula $Pr_zY_{1-z}Ni_2$ over the temperature range from 4 to 300°K. All exhibit Curie–Weiss behavior for T > 20°K, but deviate from this behavior at lower temperatures. Ternaries with z < 0.2 exhibit Van Vleck paramagnetism at 4.2°K. From the limiting susceptibility the overall crystal field splitting of the Pr^{3+} ion in $Pr_{0.1}Y_{0.9}Ni_2$ is estimated to be 98 to 141°K, depending on whether or not the sixth-order crystal field interaction term is included. Corresponding splittings for $PrNi_2$ are estimated as 94 and 136°K. Exchange in $PrNi_2$ is treated by the molecular field approach and it is established that exchange is too weak for this material to develop a spontaneous moment at low temperature. It is thus established that $PrNi_2$ is a paramagnet at 4.2°K. Exchange is very substantial, however, so that it shows saturation effects at applied fields of 10 to 20 kOe. Recently computed energies and moments of the crystal field are used to interpret the magnetic properties of the several samples studied. Agreement between calculated values and experiment for the temperature dependence of susceptibility is good for ternaries in which Pr was diluted sufficiently to render exchange insignificant. The variation of magnetization with applied field for $PrNi_2$ at 4.2°K was calculated and found to be reasonably satisfactory. (auth)

Structure and Phase Studies

41062 SOLID SOLUBILITIES OF SILVER, ALUMINUM, CHROMIUM, COPPER, AND IRON IN ZONE-REFINED BERYLLIUM. Jacobson, M. I.; Hammond, M. L. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Trans. Met. Soc. AIME, 242: 1385-91 (July 1968).

Diffusion couple sandwiches of beryllium with aluminum, cop-

per, and silver foil and diffusion couples of beryllium with two-phase alloys in the Be–Cr, Be–Fe, and Be–Ag systems were analyzed by electron beam microprobe techniques. The material used, the experimental methods for preparing the diffusion couples and the alloys, the analytical techniques, and the results obtained are described. The results are compared with those of previous investigators who used materials of lower purity. (auth)

41063 DISCUSSION OF "THE SOLUBILITY LIMIT AND DIFFUSIVITY OF CARBON IN MOLYBDENUM". Kempter, C. P. (Los Alamos Scientific Lab., N. Mex.). Trans. Met. Soc. AIME, 242: 1483(July 1968).

Rudman (Trans. TMS-AIME, 293, 1949–54 (1967)) reports an Mo–Mo_2C eutectic temperature of 2130°C. However, several other determinations are in agreement with the 2200°C value of Sykes, Van Horn, and Tucker (Trans. TMS-AIME, 117, 173–89 (1935)). If the 2200°C eutectic temperature is used in Rudman's equation, 1840 ppM is obtained as the maximum carbon solubility. References to other work on diffusion in the Mo–C system are given. (D.L.C.)

41064 TRANSFORMATION-INDUCED PRECIPITATION OF δ-PLUTONIUM IN METASTABLE CERIUM–PLUTONIUM ALLOYS. Elliott, R. O.; Miner, W. N.; Roof, R. B. Jr.; Land, C. C. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Less-Common Metals, 15: 106-7(1968). (LA-DC-9302).

Isochronal annealing data for self-irradiation damaged Ce–Pu alloys revealed an unusual increase in resistivity at 20°K, after the specimens were cycled from 20°K to annealing temperatures above the start of the $\alpha \rightarrow \gamma$ transformation and then back to low temperature. It was found that this behavior is related to the precipitation of δ-plutonium from the saturated solid solution during thermal cycling. It was concluded that deformation associated with large volume changes accompanying the repeated cycling promoted the precipitation of δ-plutonium. (M.C.G.)

41065 HIGH-TEMPERATURE, HIGH-RESOLUTION METALLOGRAPHY. Proceedings of a Symposium held in Chicago, Illinois, February 15, 1965. Aaronson, Hubert I.; Ansell, George S. (eds.). Metallurgical Society Conferences, Volume 38. New York, Gordon and Breach, Science Publishers, Inc., 1967. 389p. $25.00 Hardbound; $11.25 Paperback. (CONF-650226).

Eight papers were presented at the conference. High-temperature, high-resolution metallography is discussed in the following papers: field-ion microscopy, field emission microscopy, thermionic emission microscopy, high-temperature transmission electron microscopy, some experimental techniques and their application in field-ion microscopy, applications of field electron emission microscopy, thermionic emission microscopy-applications, and effect of grain boundary structure on precipitate morphology in Al-18 wt % Ag–on application of high-temperature electron microscopy. (R.C.K.)

41066 STRUCTURE AND ELEVATED TEMPERATURE MECHANICAL BEHAVIOR OF UNIDIRECTIONALLY SOLIDIFIED Ni–Ni_3Nb EUTECTIC ALLOY. Quinn, Robert Thomas. Bethlehem, Pa., Lehigh Univ., 1967. 70p.

Thesis.

Mechanical behavior of the unidirectionally solidified eutectic Ni–Ni_3Nb has been studied from ambient temperature to 1000°C. X-ray diffraction and metallographic techniques were used to determine the crystallographic relationships between the two phases. The crystallographic studies showed that the aligned alloy has the following relationship between the FCC α Ni and the orthorhombic (D_{2h}^{19}) Ni_3Nb phase: Interfacial plane || (111) α Ni || (010) Ni_3Nb, Growth direction || [110] α Ni || [100] Ni_3Nb. Hot hardness, hot tensile, creep-rupture, compression, and bend tests were used to investigate the mechanical properties of the eutectic alloy. The results of the mechanical tests of the controlled alloy compared to the "as-cast" alloy of the same composition prove the unidirectionally solidified Ni–Ni_3Nb eutectic alloy is strengthened in a direction parallel to the growth direction. A relationship is also shown between the softening temperatures of the intermetallic compound, the unidirectionally solidified Ni–Ni_3Nb, and the temperature at which the tensile strength of the controlled alloy begins to decrease significantly. Examination of fractured specimens shows the alloy fails after cracks are nucleated by cleavage of the Ni_3Nb phase. These cleavage failures in the intermetallic occur parallel to retained markings in a polished surface; they are probably manifestations of twinning. The retained markings are found in all specimens fractured by tensile loading, including creep-rupture, at all the test temperatures, ambient to 1000°C. Quantitative metallographic techniques reveal that the retained markings are occurring on {112} type planes in the intermetallic phase. Further, the x-ray data from the heavily marked regions show the Ni_3Nb phase has been severely deformed. The x-ray results did not give sufficiently clear orientations of the Ni_3Nb to determine an exact twinning mode. (Diss. Abstr.)

41067 BETA TO ALPHA TRANSFORMATION KINETICS IN Pu–1.5 AT. PERCENT Hf. Hanson, I. G.; Pavlick, J. E. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Nucl. Mater., 27: 100-1(July 1968).

The preparation of Pu–1.5 at. % Hf alloy is reported. Transformation kinetics of the alloy were determined using a vertical dilatometer. The specimens were heated in the dilatometer to 150°C for 30 min, then the temperature was lowered to 115°C for 10 min. The furnace was removed, and replaced with a dewar. At the conclusion of the isothermal transformation, the specimens were cycled between 100°C and –50°C. Reaction curves for the beta to alpha transformation are plotted. (J.C.W.)

41068 DIHEDRAL ANGLES OF URANIUM INCLUSIONS IN HYPOSTOICHIOMETRIC URANIUM CARBIDE. Hodkin, E. N.; Nicholas, M.; Poole, D. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 27: 80-7(July 1968). (AERE-R-5582).

Measurements have been made of the angles assumed by uranium inclusions in the grain boundaries of hypostoichiometric uranium carbide samples annealed in the temperature range of 850 to 1550°C. The distribution curves of the inclusion angles show a wide range of angles, suggesting that there is more than one characteristic dihedral angle in each sample. The medians of the inclusion angles plotted against the annealing temperature show a marked change in temperature dependence as the melting point of the inclusions is exceeded; there is an approximately linear fall from 56° at 850°C to 26° at 1100°C followed by a much slower but accelerating fall to 10° at 1550°C. (auth)

41069 FIELD ION MICROSCOPE STUDY OF THE TANTALUM–MOLYBDENUM SYSTEM. Raghavan, Nathapet Varadachari Durai. Berkeley, Calif., Univ. of California, 1967. 108p.

Thesis.

A field ion microscope study of the tantalum-molybdenum system has been carried out at liquid hydrogen temperatures. The purpose of this investigation was twofold; the first being to increase the knowledge on the field ion microscopy of alloys, and the second being to categorize the segregation effects that become important at the high concentration levels to make the alloys brittle. For this purpose, a field ion microscope fitted with a cryotip that generates a small volume of liquid hydrogen was built. Micrographs have been obtained from three alloys of the composition Mo-8 Ta, Mo-50 Ta and Ta-12 Mo and from the two pure metals. The Ta-Mo alloy micrographs obtained show far more irregularity than those from W-Mo alloys. Physical and electronic factors have been shown to affect the nature of alloy micrographs. The size differences in the two species forming the alloys have been suggested to be responsible for the presence of bright spots. The greater regularity of the Mo-8 Ta micrographs over those from Ta-10 Mo has been shown to be in accord with predictions based on field evaporation from dilute alloys and the unexpected large difference in the regularity has been accounted for by considering the polarization and heat of solution terms in the field evaporation equation. (Disser. Abstr.)

41070 PRECIPITATION HARDENING AND DISPERSION STRENGTHENING IN MAGNESIUM BASE ALLOYS. Mushovic, John Newton Jr. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 156p.

Thesis.

Precipitation phenomena and precipitate-dislocation interactions were investigated using transmission electron microscopy and mechanical properties data. Two alloys were studied in this investigation, Mg–Th–Zr and Mg–Zr. The former alloy exhibited a complex precipitation process which could be followed using hardness and tensile data. The temperature range for the tensile testing was from –196 to 200°C. Hardness data concerned with the ternary alloy show low temperature peaks which are found at lower hardnesses and shorter aging times than the higher temperature maxima. No conclusive bright field evidence was established for GP zones in samples aged at temperatures lower than 100°C. However, a dark field investigation of foils aged at 80°C for 24 hours show that magnesium matrix planes are sites for thorium atoms. At a temperature of 130°C samples aged fifty hours do not show plate-like precipitates in electron micrographs, however; matrix spots in the diffraction patterns are streaked and ordering spots observed. At 325°C, the aging sequence occurs in the following order. First, small platelets of Mg_3Th form which are ordered. There is complete coherency with the magnesium matrix and the structure of the precipitate has been identified as the DO_{19} structure. This phase lasts about three hours at 325°C. As thorium diffuses to the precipitate, a modification of this precipitate occurs and its structure changes to a face centered cubic Laves phase of Mg_2Th composition. Precipitation of the Mg_4Th phase is occurring competitively with the metastable Mg_2Th Laves phase. This equilibrium Mg_4Th precipitate has two morphologies, shape-

less and plate-like. The irregular Mg_4Th precipitate forms easily and early in the aging sequence on grain boundaries and dislocations. The plate-like precipitate forms readily after aging at 325°C for three hours. The Mg–Zr system exhibits hexagonal platelets and rectangular precipitates of $\epsilon-ZrH_2$ which form in regions of high zirconium content. In addition to this type of precipitate, spherical coherent particles have been detected when homogenized Mg–Zr is isothermally heat treated in the presence of hydrogen. The direct observation of dislocation-particle interactions provided evidence that the initial yield stress in a Mg–Th–Zr alloy aged to produce the hexagonal close packed ordered phase was controlled by particle shear. A curve of yield stress versus aging time revealed that the maximum strengthening obtained in this alloy is due to this coherent precipitate. In the overaged condition, Mg_4Th particles formed, which initially caused dislocations to bow. After about two per cent strain, the plate-like Mg_4Th equilibrium precipitate was observed to be sheared. Simultaneous with the appearance of the cracked particles, a large decrease in the work hardening behavior was observed. The yield stress of hydrided Mg–Zr alloy was consistently higher than the solution treated alloy. The non-uniformity of the large $\epsilon-ZrH_2$ particles could not explain strengthening in this alloy. It is probable that this strengthening is due to small coherent spherical particles which are observed throughout the matrix. The dislocations appeared to be held up at these particles, but the hardening mechanism was not conclusively established. The large particles effectively anchored the dislocations and caused complex tangles. The work hardening rate of this material was greatly increased by hydriding. (Disser. Abstr.)

41071 LOW-TEMPERATURE ELASTIC CONSTANTS AND SPECIFIC HEATS OF SOME δ-PHASE PLUTONIUM-GALLIUM ALLOYS. Taylor, J. C.; Linford, P. F. T.; Dean, D. J. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Inst. Metals, 96: 178-82(June 1968).

Results are presented for the temperature-dependence of the elastic moduli and specific heats of three δ-stabilized Pu–Ga alloys below 300°K. No discontinuous behaviour was observed in either property, and the elastic constants are similar to those for Pu–Al alloys. The excess specific heats, while similar among themselves, do not qualitatively resemble the excess in α–Pu, rough estimates suggest that anharmonic terms may make substantial contributions to the room-temperature excess specific heats. Self-damage energy is stored at a rate of 0.21 cal/g-atom/hr for all the alloys and evidence of partial $\delta \rightarrow \alpha$ transformation was found in a 0.75 wt % Ga alloy. Differing published data for some low-temperature physical properties point to the importance of purity as a controlling factor, and it is suggested that light-element impurities in a heavy-atom matrix may produce special effects. (auth) (UK)

41072 PHASE DIAGRAM OF ZIRCONIUM AND CHROMIUM WITH SPECIAL REFERENCE TO THE TRANSFORMATION IN THE INTERMETALLIC COMPOUND $ZrCr_2$. Shen, Yuan-shou. Corvallis, Oreg., Oregon State Univ., 1968. 127p.

Thesis.

The zirconium–chromium phase diagram was investigated in the region between 40 and 85% chromium. The $ZrCr_2$ intermetallic compound which has been the source of some controversy was especially considered. It was found that $ZrCr_2$ transforms from the low temperature C-15 ($MgCu_2$, fcc) structure to the high temperature C-14 ($MgZn_2$, hcp) structure between 1550 and 1600°C, just the opposite transformation from previously reported results. X-ray diffraction and metallographic methods were used to determine that this transformation is a shear type transformation which occurs on the (111) plane along the [11$\bar{2}$] direction. The shear mechanism involved in the transformation was determined as a sluggish martensitic transformation. (Diss. Abstr.)

41073 LATTICE CONSTANTS, THERMAL EXPANSION COEFFICIENTS, AND DENSITIES OF MOLYBDENUM AND THE SOLUBILITY OF SULPHUR, SELENIUM, AND TELLURIUM IN IT AT 1100°C. Straumanis, Martin E.; Shodhan, Ramesh P. (Univ. of Missouri, Rolla). Z. Metallk., 59: 492-5(June 1968).

A lattice parameter of $a_{25} = 3.14700 \pm 0.00001$ Å was obtained for a nominally 99.9935% pure molybdenum; for a 99.95 preparation the constant at 25°C was 3.14696 ± 0.00003 Å. The thermal expansion coefficient α between 15 and 65°C was $4.89 \times 10^{-6}°C^{-1}$. The experimental density of the last sample d_{25} was 10.222 ± 0.036 g cm^{-3} agreeing within the limits of error with the x-ray density $d_x = 10.2201$ g cm^{-3} at 25°C. The structure of the pure Mo is, therefore, sound. Upon heating molybdenum at 1100°C with sulfur, selenium, or tellurium a small expansion of the lattice occurs increasing from sulfur to tellurium. It is assumed that this expansion is due to some solubility (below 2 and 1 atomic %) of the chalcogenides in the metal. The thermal expansion coefficients of the alloys are slightly larger than the coefficient of pure molybdenum. (auth)

41074 COMMENTS ON SELF-DIFFUSION IN ALPHA ZIRCONIUM. Dyment, F. (Consejo Nacional de Investigaciones Cientificas y Tecnicas, Buenos Aires); Fainstein, D.; Libanati, C. M. Scr. Met., 2: 201-4(Apr. 1968).

Comments on an analysis of self diffusion in alpha-Zr by Naik and Agarivala [Acta Met., 15: 1521(1967)] are presented. It is noted that in the formula $D/D_v = g\,(D_d/D_v) + 1 - g$ where D is the apparent bulk diffusivity, D_v the diffusion coefficient in a crystal free from dislocations, D_d the diffusion coefficient along dislocations, and g the fraction of atoms that are in dislocation, the Dd/Dv ratio for Ag was substituted for Zr. Data and information are presented to show that substitution of these data is not permissible. (J.R.D.)

Radiation Effects

Refer also to abstract 42338.

41075 (N-68-13825) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Report, July 21–October 21, 1966. Schwanbeck, C. A. (Lockheed-Georgia Co., Marietta). Nov. 1966. Contract NAS3-7985. 72p. (NASA-CR-91519; LAC-ER-8811; QR-5). CFSTI.

An in-pile test program designed to determine the effects of a combined nuclear–cryogenic environment on the mechanical properties of materials (metals) used in the construction of nuclear rocket systems is reported. Studied were the effects of: (1) 10^{18} n/cm^2 (E > 0.5 MeV) at 30°R on tensile properties of titanium-base alloys; (2) irradiation temperature (30°R to 540°R) on tensile properties of aluminum 1099-H14 following irradiations up to 3×10^{17} n/cm^2 (E > 0.5 MeV); (3) annealing following irradiation at 30°R to 10^{17} n/cm^2 (E > 0.5 MeV) on tensile properties of aluminum 1099; and (4) irradiation at 30°R on axial, low-cycle fatigue properties of titanium-base alloys. All out-of-pile tensile testing and in-pile testing of aluminum 1099, Ti–55A, Ti–5Al–2.5 Sn (ELI), Ti–5Al–2.5 Sn (Std. 1), and Ti–6Al–4V (annealed) was completed. Increases in strength functions, accompanied by moderate reductions in ductility, were observed in the titanium alloys and there was no evidence of saturation at 10^{18} n/cm^2 (E > 0.5 MeV). Modification of two test loops for low cycle fatigue, including calibration of the load monitoring instrumentation was completed and the modified loops were used to perform out-of-pile tests at room temperatures; and at 30°R during irradiation, following irradiation to 10^{17} n/cm^2, and unirradiated. Cryogenic strengthening of Titanium 55A had a greater effect on tensile properties than on fatigue life; irradiation at 30°R to 10^{17} n/cm^2 produced a greater effect at high load levels than loads below 85% of the nominal F_{tu}. The effect of cryogenic strengthening of both interstitial levels of titanium–5 Al–2.5 Sn on fatigue life was as pronounced as for tensile properties. (STAR)

41076 (ORNL-tr-1932) THE EFFECT OF NEUTRON IRRADIATION ON THE PLASTIC DEFORMATION OF SINGLE CRYSTALS OF IRON WITH DIFFERENT CARBON CONTENT. I. THE YIELD STRESS AT THE BEGINNING OF DEFORMATION. Seidel, G. P. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Phys. Status Solidi, 25: 175-88(1968). 16p. Dep. CFSTI.

An investigation was made of the mechanism of radiation hardening for iron single crystals with small amounts of carbon (20 and $\lesssim$8 ppM by weight). The dependence of the yield stress on the irradiation dose and the deformation temperature was measured and annealing experiments were performed. The radiation-induced increase of the yield stress is strongly dependent on the carbon content, saturates completely at a rather low dose (3×10^{17} n/cm^2) and recovers only above 230°C. The temperature dependence of the yield stress can be described by the interaction between the dislocation and defects with tetragonal symmetry. The results are interpreted in terms of dislocation obstacles which are produced by neutron irradiation and which consist of complexes of carbon atoms and vacancies or interstitials. (auth)

41077 POST-IRRADIATION ANNEALING BEHAVIOUR OF FISSION GAS BUBBLES IN VARIOUS PURITIES OF URANIUM. Hudson, B. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 27: 54-63(July 1968). (AERE-R-5706).

The gas bubble distribution in irradiated uranium foils subjected to a wide range of annealing treatments has been studied by transmission electron microscopy. In the absence of stress, the growth of fission gas bubbles ~100 Å dia in the alpha phase is extremely slow for both pure and adjusted uranium for times up to 1000 hr. Post-irradiation annealing at 600°C of material irradiated at low temperature is not equivalent to irradiation at 600°C. In the absence

of stress, the migration of fission gas bubbles ~100 Å dia at 800°C for pure and adjusted uranium is slow but measurable. The application of stress during annealing of ~100 Å bubbles in the α phase at 600°C does not noticeably affect the coarsening rate. The gas bubble density increases with dose when the gas bubbles are formed after irradiation but is independent of dose (after very small doses) for high-temperature irradiations. (auth)

41078 EFFECT OF IRRADIATION ON STRAIN AGEING IN ANNEALED ZIRCALOY-2. Veevers, K.; Rotsey, W. B. (Australian Atomic Energy Commission, Sydney). J. Nucl. Mater., 27: 108-11(July 1968).

Strain aging and the effects of irradiation on Zircaloy-2 are in progress. Longitudinal and transverse tensile specimens with a cross section of 1 × 4 (mm) and a gage length of 20 mm were machined from rolled sheet. After machining, specimens were annealed for 3 hr at 650°C in a vacuum of $<10^{-5}$ torr and then chemically polished. The amounts of interstitial elements in the experiments are tabulated. Tensile tests were performed and strain aging was measured by the parameter which is defined as the ratio of increase in flow stress to flow stress at which the test was interrupted. The effects of aging temperature and time are shown. Specimens were irradiated in a fast flux of 2×10^{13} n/cm^2 sec to an integrated dose of 3.4×10^{19} nvt > 1 MeV. Results show that irradiation decreased the strain aging in the longitudinal specimens to about one third of the unirradiated value and completely suppressed it in the transverse specimens. Transverse direction was almost completely restored. Evidence shows that strain aging was probably caused by oxygen. (auth)

41079 DISLOCATION HALOS IN AN IRRADIATED NICKEL-BASE ALLOY. Rau, R. C.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati). Phil. Mag., 18: 209-12(July 1968).

Transmission electron microscopy was used to examine a neutron-irradiated nickel-base alloy doped with boron enriched in the ^{10}B isotope. The observations showed concentric circular halos of dislocations, many of them loops, surrounding some of the carbide precipitates in the specimens. These halos are believed to be planar segments of spherical damage shells surrounding regions of ^{10}B concentration, and to represent the resting points of helium and lithium atoms produced by the $^{10}B(n,\alpha)^7Li$ reaction. (auth) (UK)

41080 THE INFLUENCE OF γ-RAY IRRADIATION TO PRECIPITATION OF CARBON IN α-IRONS. T'ung, Chih-shen; Wang, K'uei-sheng; Feng, Huan. Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh, No. 3, 37-43(Dec. 1961). (In Chinese).

The influence of ^{60}Co γ-ray irradiation on precipitation of carbon in α-irons by internal friction method is studied. The diameter of specimen is 1.25 mm. Results show that the height of the internal friction peak is decreased by γ-irradiation, and further decreases by annealing at 100°C after irradiation, but increases at 312°C. Hence it can be concluded that the decreasing of height of internal friction peak after irradiation is due to carbon atoms attracted to defects of radiation. (JPRS)

41081 WORK HARDENING CHARACTERISTICS OF NEUTRON IRRADIATED IRON. Ohr, S. M. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Scr. Met., 2: 213-16 (Apr. 1968). (ORNL-P-3628).

Observations on the work hardening characteristics of neutron irradiated polycrystalline Fe are presented. Aspects of the analogy between neutron irradiation and plastic prestraining are emphasized. It is noted that the structure of irradiated samples corresponds to that of more heavily deformed unirradiated samples. (J.R.D.)

Ceramics and Cermets

Refer also to abstracts 40993 and 40994.

41082 (CEND-2936-335) IRRADIATION TESTING OF CERAMIC FUELS. Final Summary Report. Chernock, W. P.; Zuromsky, G.; Christopher, S.; Koziol, J. J. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Mar. 1968. Contract AT(30-1)-2936. 282p. Dep. CFSTI.

Activities in a program to develop high-burnup ceramic fuels are reported. Results of research are presented in six sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 41086, 41087, 41113, and 41127–41129.

41083 ROST KRISTALLOV. TOM VIII. TRUDY SIMPOZIUMA PO ROSTU KRISTALLOV VII MEZHDUNARODNOGO KONGRESSA KRISTALLOGRAFOV, IYUL' 1966 G. CHAST' II. ADSORBTSIYA PRIMESEI EPITAKSIYA I MONOKRISTALLICHESKIE PLENKI. (Crystal Growth. Volume 8. Proceedings of the 7th International Congress of Crystal Growth, July 20–21, 1966. Part II. Adsorption of Impurities, Epitaxy and Monocrystal Films). Sheftal, N. I. (ed.). Rost Kristallov, Akad. Nauk SSSR, Inst. Kristallogr., 8: 1-374(1968). (In Russian). (CONF-660724-(Pt.2)).

A total of 52 papers was presented at the congress. A separate abstract was prepared for each of two papers. Papers for which no abstracts were prepared are concerned with impurity absorption, epitaxy, and structure of monocrystalline films. (J.R.D.)

For abstracts of individual sections see: 41091 and 41137.

Corrosion and Erosion

Refer also to abstract 41004.

41084 (ORNL-TM-2199) OXIDATION OF PYROLYTIC-CARBON-COATED FUEL PARTICLES BY LOW CONCENTRATIONS OF WATER VAPOR. Baker, J. E.; Overholser, L. G. (Oak Ridge National Lab., Tenn.). Apr. 10, 1968. Contract W-7405-eng-26. 55p. Dep. CFSTI.

The oxidation of various batches of pyrolytic-carbon-coated fuel particles by water vapor was studied at 1100 to 1400°C using flowing helium-water vapor mixtures having water vapor concentrations of 250 to 1000 ppM and a total pressure of 1 atm. Rates of reaction of water vapor with pyrolytic carbon coatings were determined from continuously recorded weight changes and from analyses of effluent gases for reaction products. Percentage failure of coatings was determined from the quantity of uranium and/or thorium leached by acid from the oxidized coated fuel particles. Differences in oxidation rates were observed for the various batches of coated particles which could not be correlated satisfactorily with properties of the coatings such as density, anisotropy, and crystallite size. Percentages of failed coatings at constant burnoff also varied from batch to batch. Limited data obtained from exposure of silicon carbide coatings and fuel sticks to water vapor are included. (auth)

Preparation and Fabrication

Refer also to abstracts 41022, 41028, 42344, and 42570.

41085 (BNWL-SA-1666) DEVELOPMENT OF MIXED-NITRIDE FUEL MATERIALS OBTAINED BY CARBOTHERMIC REDUCTION OF OXIDES. Weber, E. T.; Greenhalgh, W. O.; Gibby, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 29, 1968. Contract AT(45-1)-1830. 25p. (CONF-680601-30). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The reactions for the synthesis of nitrides are discussed. The particle-bed reactor for carbothermic synthesis of UN–PuN is described, and chemical analyses of $U_{0.8}Pu_{0.2}N$ products are given. Sintering studies indicate that densities of 85 to 94% TD may be obtained by sintering for 3 to 6 hr at 1700 to 1900°C, and the resulting microstructures are shown. Thermal diffusivity of $U_{0.8}Pu_{0.2}N$ was measured at 200 to 1600°C and thermal conductivity values calculated. Results of preliminary melting studies are given. No evidence was found for incompatibility between mixed nitrides and 304 stainless steel at 650 and 1000°C. (D.L.C.)

41086 (CEND-2936-335, II.1-20) EX-REACTOR PROPERTY EVALUATIONS. (Combustion Engineering, Inc., Windsor, Conn.).

Data on the thermal conductivity, melting point, thermal expansion, and corrosion behavior of CeO_2-base UO_2 and UO_2–ZrO_2-base fuel compositions are reported. The ZrO_2 used in the compositions was stabilized with CaO. Equipment and techniques used in the experiments are described and illustrated and structural changes are shown by photomicrographs. (P.G.C.)

41087 (CEND-2936-335, III.1-10) FABRICATION OF IRRADIATION TEST SAMPLES. (Combustion Engineering, Inc., Windsor, Conn.).

Flow sheets are shown for the preparation of ZrO_2 base and CeO_2 base fully enriched UO_2 irradiation test samples, as are methods for cladding, assembly, and end plug welding. Results of x-ray examinations, metallographic and chemical analyses, and corrosion tests are discussed. (P.G.C.)

41088 (WAPD-TM-721) FABRICATION OF LOW DENSITY URANIA–THORIA FUEL PELLETS (LWBR DEVELOPMENT PROGRAM). Williams, G. H.; Rodriguez, M. K.; Johnson, R. G. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1968. Contract AT-11-1-GEN-14. 46p. Dep. CFSTI.

Low-density seed-size (<0.250-inch diameter) UO_2–ThO_2 pellets were fabricated utilizing assorted volatile additives. Dextrose

D-16 sugar (size –140/+200 mesh) produced acceptable porosity characteristics. Reducing the binder content reduced the amount of microcracking and elongated intergranular porosity. Micronizing subsequent to centrifuging also significantly reduced the amount of this porosity in ball-milled, acid-leached powder. Dextrose additions to produce 80, 85, and 90% of theoretical density sintered pellets with high-density matrices were determined. (auth)

41089 PREPARATION OF AN ACTINIDE METAL MONOCARBIDE FROM AN OXIDE THEREOF. Hanson, Lloyd A. (to North American Rockwell Corp.). U. S. Patent 3,386,811. June 4, 1968. Filed June 3, 1966.

A method is described for converting an actinide metal oxide to the monocarbide by carbothermic reduction, which may be performed at a lower temperature than previously reported and which removes trace impurities of F and O. The actinide metal oxide, typically UO_2, is heated together with C and a small amount of Si under vacuum at a temperature of about 1700 to 1800°C to convert the UO_2 to UC. (Offic. Gaz.)

41090 STRUCTURAL STABILIZATION OF Sm_2O_3, Gd_2O_3, AND Nd_2O_3 WITH WO_3. Crick, R. F.; Berard, M. F.; Wilder, D. R. (Ames Lab., Iowa). J. Nucl. Mater., 27: 97-9(July 1968). (IS-1687).

The parameters for formation of rare earth tungstates are presented. Crystalline properties of samaria are reported. Mixtures used were 10, 15, 20, and 25 wt % WO_3. The 20 wt % mixture gives the best stabilization. Investigation of Gd_2O_3 and Nd_2O_3 showed that stabilization can be complete at 20 wt % WO_3 after heat treatment at 1400°C and 30 min for Gd_2O_3 and at 1300°C and 300 min for Nd_2O_3. (J.C.W.)

41091 BEHAVIOR OF RARE EARTH IMPURITIES IN CeO_2 AND HfO_2 MONOCRYSTALS DURING CRYSTALLIZATION IN MELTS. Zonn, Z. N.; Ioffe, V. A. (Inst. of Chemistry of Silicates, Leningrad). Rost Kristallov, Akad. Nauk SSSR, Inst. Kristallogr., 8: 78-80(1968). (In Russian).

From 7th International Congress of Crystal Growth, Moscow.

Monocrystals CeO_2, HfO_2, and ThO_2 with fluorite structures were prepared from a solution in melt using solvents of various ratio of KF, $BaO-B_2O_3$ and $PbO-PbF_2$ mixtures. The EPR and luminescence spectra of prepared mixtures were studied. A simple mixture of rare earth oxides and CeO_2 produced satisfactory monocrystals only with Dy, Tb, Er, and Yb impurities; it was impossible to obtain crystals with Nd and Pr admixtures. Content of rare earth impurities in simple oxide mixtures in HfO_2 and ThO_2 monocrystals was 0.01 of the introduced amount. Preparation of fluorite structure monocrystals CeO_2, HfO_2, and ThO_2 from a solution in melt using solvents of various ratio of KF, $BaO-B_2O_3$ and $PbO-PbF_2$ mixtures is described. (R.V.J.)

41092 NEW METHOD TO PREPARE CERAMIC RAW MATERIALS. Lorant, M. Chem. Rundsch., No. 41, 755(Oct. 11, 1967).

A quick-freeze method of preparing ceramic raw materials for manufacturing processes was developed. A high-purity sulfate or acetate solution is sprayed into a container of swirling hexane which is a volatile liquid hydrocarbon from petroleum, held at low temperature. The droplets freeze into solid spheres. The spheres are then freeze-dried and heat treated to remove water and other volatile components. Based on surface area measurements, the particles derived from the spheres can be 100 to > 5000 Å in dia. The new method was used to produce uniformly fine powders of alumina, magnesia, thoria and homogeneous ferrites, garnets and other ceramics. The method is particularly useful for analyzing the effect of additives on densification and grain growth in the manufacture of ceramic materials. (auth)

41093 SINTERED URANIUM DIOXIDE. Elyard, Charles Anthony; Potter, Terrence Jefferson (to United Kingdom Atomic Energy Authority). British Patent 1,116,663. June 12, 1968. Filed Jan. 22, 1965.

Addition of 1.25 to 3 wt % of Y_2O_3 to an UO_2 nuclear reactor fuel prevented columnar grain growth in the ceramic even when it was subjected to a severe temperature gradient at a temperature up to 2000°C. (P.G.C.)

41094 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF GRAPHITE. Jenkins, Mansel John (to United Kingdom Atomic Energy Authority). British Patent 1,117,606. June 19, 1968. Filed Apr. 1, 1965.

For nuclear reactor moderator structures graphite having an isotropic high thermal expansion is produced by adding a controlled amount of S to pitch or bitumen, coking the mass to eliminate all S atoms before completion of the carbonization, and converting the resultant coke to graphite by heating to 1300°C. (P.G.C.)

41095 PRODUCTION OF TECHNICAL ZIRCONIUM DIOXIDE FROM BADDELEYITE CONCENTRATES. Lainer, A. I.; Kolenkova, M. A.; Rybachuk, N. T. Tsvetn. Metal., No. 5, 73-5(May 1968). (In Russian).

Concentrates were processed with solutions of sulfuric and nitric acids (5 to 20%). The presence in the concentrate of magnesium minerals (ilmenite, magnetite, and pyrochlore) makes it possible to use electromagnetic beneficiation, which significantly reduces the Fe_2O_3 content in the nonmagnetic fraction. Subsequent leaching with 5% HCl for 1 hr at 950°C produces zirconium dioxide. The requirements with respect to purity were satisfied. (tr-auth)

Properties Evaluations

Refer also to abstracts 40094, 41085, and 42344.

41096 (CEA-R-3488) STUDY OF THE THERMAL CONDUCTIVITY OF MIXED URANIUM–PLUTONIUM OXIDES. Van Craeynest, Jean-Claude; Weilbacher, Jean-Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1968. 19p. (In French). Dep.

The dependence of the thermal diffusivity of mixed oxides $(U_{0.8}Pu_{0.2})O_{2+x}$ on the value of x was measured. It was found that the thermal diffusivity decreases strongly when x changes from 0 to 0.02. These measurements were used to calculate the thermal conductivity. From 0°C to 2000°C, the thermal conductivity of the stoichiometric oxides is greater than the conductivity of the hyperstoichiometric and hypostoichiometric oxides. (auth)

41097 (GEAP-5493) EFFECT OF DENSITY ON THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE. Asamoto, R. R.; Anselin, F. L.; Conti, A. E. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Apr. 1968. Contract AT(04-3)-189. 52p. Dep. CFSTI.

The thermal conductivity of 82, 86, 91, and 95% TD sintered uranium dioxide has been measured to within ±10% between 800 and 2000°C, in an argon atmosphere by the radial heat flow technique. The data indicate that use of the Loeb equation, the Maxwell-Eucken equation, or currently recommended modifications of these thermal-conductivity-density relationships are not valid in the temperature and density ranges investigated. Thermal conductivity values for uranium dioxide were related to both temperature and density by the equation $k = 0.0130 + 1/T(0.4848 - 0.4465D)$ (watts/cm-°C) for T between 800 and 2000°C, and D between 82 and 95% TD. The time required for microstructural and/or density changes to occur in fuel elements under irradiation is short relative to its total exposure time. Because the thermal conductivity of a typical oxide fuel has been found to be quite dependent on density, a model utilizing the relationship derived in this investigation is described in which thermal conductivity and $\int kdT$ curves corrected for fuel densification can be generated. The thermal conductivity characteristics of hot-pressed uranium dioxide are also discussed. (auth)

41098 (JAERI-4045) PROPERTIES AND STRUCTURES OF URANIUM OXIDES WITH EMPHASIS ON NONSTOICHIOMETRY. Ishii, Tamotsu; Naito, Keiji (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Dec. 1967. 30p. (In Japanese). Dep.

There are many kinds of uranium oxide phases, UO_2, U_4O_9, U_3O_7, U_3O_{13} (or U_2O_5 or U_8O_{21}), U_3O_8 and UO_3, with wide ranges of nonstoichiometry. Reported experimental data concerning phase equilibria, thermochemical properties, crystal structures, phase transitions, and electrical properties are summarized and assessed chiefly from the view point of nonstoichiometry. Particular emphasis was placed on the phase boundaries and equilibrium pressures of oxygen in the phase diagram, variation of thermodynamic functions in a range approaching to $UO_{2.00}$, crystal structures, and electric conductivity mechanisms. Electrical properties of uranium oxides, which depend on temperature and O/U composition, were investigated and the conduction mechanism was discussed from the experimental results. The nature and mechanism of phase transitions in U_4O_9 and U_3O_8 are discussed. (auth)

41099 (JUL-511-RX) UEBER DIE WAERMELEITFAEHIGKEIT VON COATED-PARTICLES-SCHUETTUNGEN UNTER FUELLGAS ALS FUNKTION DES GASDRUCKES UND DER TEMPERATUR. (The Thermal Conductivity of Coated-Particles Fillings Under Supporting Gas as a Function of Gas Pressure and the Temperature). Leyers, H. J.; Binkele, L.; Beuth, J. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Jan. 1968. 19p. (In German). Dep.

The heat conductivity of cylindrical coated-particle fillings under helium and argon was measured as a function of the temperature up to 1400°C and the filling gas pressure up to 25 atm. Heat conductivity numbers between 0.015 and 0.045 W/cm° were obtained for helium and between 0.003 and 0.015 W/cm° for argon with the coated particle charge WM 43. (tr-auth)

41100 (ORNL-tr-1942) THERMODYNAMIC ANALYSIS OF THE SOLID SOLUTIONS OF CARBON, NITROGEN, AND OXYGEN IN NIOBIUM AND TANTALUM. Fromm, E. Translated for Oak Ridge National Lab., Tenn., from J. Less-Common Metals, 14: 113-25(1968). 16p. Dep. CFSTI.

Data necessary for the thermodynamic analysis of the α-solid solution phase for the systems Nb–C, Nb–N, Nb–O, Nb–C–O, Ta–C, Ta–N, Ta–O, and Ta–C–O were compiled and discussed. In addition, the equilibrium pressures of N_2, Co, O_2, O, NbO, NbO_2, TaO, and TaO_2 are given over the solid solution region of niobium and tantalum as a function of the temperature and concentration. From this, it is possible to estimate the role which is played by the individual gas absorption and degassification reactions in the various pressure and temperature ranges. (auth)

41101 (WANL-TME-1761) COMPRESSIVE CREEP BEHAVIOR OF NIOBIUM CARBIDE-GRAPHITE COMPOSITES. Brizes, Wm. F.; France, L. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). [1967]. 22p. Dep. CFSTI.

The compressive creep behavior of cold pressed and sintered niobium carbide–graphite composites has been studied as a function of temperature and composition. The equation $\epsilon = A\sigma_0^{1.4} \exp\{5.0\,[(\text{volume \% porosity}/100)] + [(\text{volume \% NbC}/100)]\}$ is proposed to represent the creep behavior of graphite-rich composites as a function of composition and stress. The activation energy, activation volume and stress dependence of creep were determined and the possible mechanisms controlling deformation were examined. (auth)

41102 OXYGEN DIFFUSION IN HYPOSTOICHIOMETRIC ZIRCONIUM OXIDE IN THE TEMPERATURE RANGE OF 875 TO 1050°C. Rosa, C. J.; Hagel, W. C. (Univ. of Denver). Trans. Met. Soc. AIME, 242: 1293-8(July 1968).

An attempt is made to determine the diffusion coefficients of oxygen ions in hypostoichiometric zirconium oxide. A phenomenological theory is developed for three-phase, unidirectional volume diffusion of a gaseous species from a planar source. Knowledge about oxygen diffusion in α and β zirconium and experimentally measured rates of movements of interfaces permit the evaluation of oxygen ion diffusivities in ZrO_{2-x}. The results conform to the relationship: $D_{O^{2-}-ZrO_2} = 1.36 \times 10^{-4} \exp(-28{,}400/RT)$ sq cm per sec, for the temperature range of 875 to 1050°C. (auth)

41103 COMPRESSIVE CREEP OF POLYCRYSTALLINE URANIUM MONONITRIDE IN NITROGEN. Vandervoort, Richard R.; Barmore, Willis L.; Cline, Carl F. (Univ. of California, Livermore). Contract W-7405-eng-48. Trans. Met. Soc. AIME, 242: 1466-7(July 1968). (UCRL-70709).

The creep of stoichiometric UN was studied at 1500 to 1800°C at compressive stresses of 2000 to 5000 psi in 200 mm N_2. The creep rate was found to be proportional to the sixth power of the stress, and the average activation energy was 75 ± 10 kcal/mole. The creep is not sensitive to grain size. The results indicate that diffusion of uranium is the rate-controlling diffusion process during creep. (D.L.C.)

41104 A COMPARISON BETWEEN THE GAS PENETRATION OF TWO SAMPLES OF SPECIAL SYNTHETIC COAL, ONE OF WHICH WAS METALLIZED GALVANICALLY, THE OTHER LEFT UNTREATED, BY MEANS OF A HELIUM LEAK DETECTION METHOD. Oelschig, W.; Vogel, H. J. (Boelkow GmbH, Munich). Atompraxis, 14: 119-20(Mar. 1968). (In German).

The gas penetration of two samples of special synthetic coal was tested by means of a helium leak detector. One sample was metallized galvanically, whereas the other was left untreated. It was found that untreated synthetic coal satisfies all the leak tightness requirements of nuclear research for radioactive surroundings. (auth)

41105 YIELD AND FLOW OF POLYCRYSTALLINE URANIUM DIOXIDE. Byron, J. F. (Univ. of Liverpool). J. Nucl. Mater., 27: 48-53(July 1968).

The deformation phenomena associated with the yield and flow of polycrystalline specimens of uranium dioxide tested in compression at temperatures between 600 and 2000°C are reported. The proportional limit for stoichiometric uranium dioxide was found to be strongly temperature-dependent. Increasing the oxygen content to approximately $UO_{2.02}$ reduced the proportional limit and flow stress and weakened the grain boundaries. (auth)

41106 ABSTRACTS OF PAPERS PRESENTED AT THE EIGHTH CONFERENCE ON CARBON, BUFFALO, NEW YORK, JUNE 19–23, 1967. Carbon, 6: 199-241(May 1968). (CONF-670640).

Abstracts of the 186 papers presented are arranged according to the following subject categories: electronic properties; mechanical properties and irradiation; pyrolysis; carbon products and their properties; reactivity and surfaces; structure and graphitization. An index of authors is appended. Abstracts of the papers which fall within the subject scope of NSA will be published as the full papers become available, and will be found in the report number index under CONF 670640. (UK)

41107 EFFECTS OF CARBON CONTENT ON THE PROPERTIES OF SINTERED WC–NbC–10 PERCENT Co ALLOYS. Suzuki, Hisashi; Yamamoto, Takaharu (Tokyo Univ.). Trans. Jap. Inst. Metals, 9: 77-82(Apr. 1968).

Properties of WC–NbC–10% Co cemented carbides have been studied in relation to carbon and niobium carbide contents. The measured values of their properties were examined in comparison with the results so far obtained for various cemented carbides. The experimental results are as follows. (1) Niobium carbide is insoluble in the binder phase, as in the case of tantalum or titanium carbide in WC–TaC–Co, WC–TiC–Co, or WC–Ti(Ta)C–Co alloys. (2) The amount of tungsten carbide dissolved in niobium carbide is about 18%. (3) The composition of the binder phase and the carbon content of the niobium carbide (NbC–WC double carbide) phase vary regularly in the three-phase region due to the slight change in carbon content. This resulted in regular changes in other various properties, as has been confirmed in the above various alloys. (4) The three-phase region extends with increasing niobium carbide content owing to the changes in the carbon content of the niobium carbide phase. (5) The phase diagram of the WC–NbC–10% Co alloy system has been established. (6) The WC–NbC–Co material appears to occupy a position intermediate between WC–TaC–Co and WC–TiC–Co materials. (auth)

41108 LOW TEMPERATURE THERMAL CONDUCTIVITY OF SELECTED RARE EARTH OXIDES. Warmkessel, Barry Murice. Tempe, Ariz., Arizona State Univ., 1968. 102p.

Thesis.

The thermal conductivity of ceramic stoichiometric and slightly reduced ceria as well as erbia and praseodymium oxide ($PrO_{1.83}$) was measured on an apparatus designed and built to operate in the temperature region from 3 to 300°K. The stability of these materials under atmospheric conditions was also investigated. The thermal conductivity of ceria was found to vary, within experimental error, as T^{-1} above 70°K and as $T^{2.2}$ below 30°K. A maximum in the thermal conductivity occurred at 700 milli-watts/cm deg between 38 and 48°K. The thermal conductivity of ceria was altered slightly below 40°K after reduction. The thermal conductivity of erbia was depressed through most of the temperature range investigated when compared to that of ceria. An anomalous depression, found at about 4°K, is interpreted to correspond to a transition of erbia from the paramagnetic to the antiferromagnetic state. The thermal conductivity of $PrO_{1.83}$ was more depressed than that of erbia. A maximum was found at about 80°K, and anomalous depressions occurred at 31 and 50°K. (Diss. Abstr.)

41109 ELEVATED TEMPERATURE COMPRESSION DEFORMATION BEHAVIOR OF TUNGSTEN CARBIDE–COBALT ALLOYS. Smith, James Thomas. Bethlehem, Pa., Lehigh Univ., 1967. 83p.

Thesis.

The compressive creep deformation of two-phase tungsten carbide-cobalt alloys has been investigated at 800, 900, and 1000°C for stresses of 10,000 to 110,000 psi. The alloy consists of WC particles dispersed in the Co matrix. Five alloys with controlled WC particle size were investigated. They were: WC-12% Co with 2.2 micron WC particles, with 3.3 micron WC particles, and with 4.5 micron WC particles; and WC-15% Co with 3.4 and with 4.2 micron WC particles. At each temperature studied, the WC-12% Co alloys showed a decreasing steady state creep rate with increasing WC particle sizes for low creep stress levels. At high stress levels, the steady state creep rate was observed to increase with increased WC particle size. It was shown that the steady state creep rate ($\dot{\epsilon}$)-creep stress (σ) relation at constant temperature could be described by the equation: $\dot{\epsilon} = A\sigma^n$ where A is a constant and n has values of 1.1 to 1.5 at low stresses and 3 to 4.5 at high stresses. These observations with additional considerations of the creep behavior indicated that two mechanisms were rate determining during deformation of the WC-12% Co alloys. At high stresses, the mechanism postulated to describe steady state creep deformation was the looping of dislocations in the Co matrix between WC particles and the climb of pinched off loops. The activation energy for this creep mechanism was 61.4 Kcal/mole. The diffusion of Co in the matrix around WC particles was suggested as the rate controlling steady state creep mechanism at low stresses. An activation energy of 52.4 kcal/mole was determined for this process. The WC-15% Co alloys showed greater creep deformation than the 12% Co alloys for similar test conditions. However, the

creep behavior of the 15% Co alloys was qualitatively similar to that of the 12% Co alloys. It was concluded that these alloys deformed during steady state creep by the same mechanisms as the 12% Co alloys. The possibility of WC particle deformation during creep was investigated by light microscopy and electron microscopy techniques. No evidence of particle fracture or slip was found. A discussion of strain rate and its influence on WC deformation was presented. It was concluded the creep rate was not sufficiently fast to cause particle deformation. (Disser. Abstr.)

41110 HIGH-TEMPERATURE THERMAL CONDUCTIVITY OF SINTERED URANIUM DIOXIDE. Ainscough, J. B.; Wheeler, M. J. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Phys., D, 1: 859-68(July 1968).

Thermal conductivity values are calculated from 700 thermal diffusivity measurements between 970 and 2020°K on 25 samples of sintered 2.7% enriched $UO_{2.00}$, 97% theoretical density. The measurements were made using the modulated electron-beam technique and the thermal conductivities of all the samples, derived by using Moore and Kelley's (1947) specific heat values, are represented by $k = (0.0227\ T + 3.38)^{-1} + 6.6 \times 10^{-13}\ T^3$ w cm^{-1} $degK^{-1}$ (970 – 2020°K) the 95% confidence limits being ±14½%. (auth) (UK)

41111 ELECTRICAL PROPERTIES OF COMPLEX NON-STOICHIOMETRIC CARBIDES ZrC–Nb AND NbC–Zr. Avgustinik, A. I.; Golikova, O. A.; Kudryasheva, L. V.; Ordan'yan, S. S.; Snetkova, V. A. (Leningrad Technological Inst. Inst. of Semiconductors, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 904-8 (June 1968). (In Russian).

Electric properties of the complex defective monocarbides through ZrC–Nb and NbC–Zr in the ternary system Zr–C–Nb and their comparison with the defective alloys ZrC_x and NbC_x were used to differentiate the effect on electric properties of defects in the carbon sublattice present in the alloy and of additions of metals with valences different from the basic metals. The replacement of a part of the metallic atoms of the monocarbide with metal atoms of very high valence led to an increase of the concentration of conduction electrons in comparison with that observed in pure monocarbides. Addition of metals of very low valence led to converse effects. The zone structure in the complex alloys ZrC–Nb (up to 20 at. % Nb) and NbC–Zr (up to 15 at. % Zr) is probably close to the zone structure of the corresponding monocarbides. On the basis of these data it can be assumed that during the gradual mutual substitution of the metallic atoms in the phases isodefective with respect to carbon a gradual transition between the electron structure and the zone structure of the monocarbides of the Zr and Nb matrix must occur. (tr-auth)

Structure and Phase Studies

Refer also to abstracts 41098 and 41107.

41112 (BNWL-SA-1903) MICROSCOPY STUDIES OF GRAPHITIZATION. Woodruff, E. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 17, 1968. Contract AT(45-1)-1830. 7p. (CONF-680620-1). Dep. CFSTI.

From 18th Annual Meeting on Carbonization and Graphitization, Paris, France.

A subgranular structure has been identified in graphites representing a broad range of morphological characteristics. Subgrains have been defined as lamellar features bounded on basal sides by slip zones and at the edges by tilt boundaries. Subgrains may be distinguished from crystallites by size and by the continuous nature of their boundaries. Basal subgrain boundaries begin to develop during calcining or baking while edge boundaries do not appear until polygonization occurs at about 2700°C. Modifications of subgrain structures are introduced at low temperatures by stresses and inclusions and at high temperatures by external stress and interactions with metals. Internal stresses apparently cause a reduction of subgrain thicknesses above 3000°C by the creation of new slip zones. Studies of granular forms of graphite have been extended to include new variations found in graphite crystallized from the liquid phase. (auth)

41113 (CEND-2936-335, I.1-22) PHASE RELATIONSHIPS. (Combustion Engineering, Inc., Windsor, Conn.).

Methods of preparation, sintering procedures, and heat treatment techniques used in preparing specimens for a study of phase relationships in the UO_2–ZrO_2–CaO and the UO_2–CeO_2 systems of reactor fuels are reported. A single phase, face centered cubic region was developed in the ZrO_2 rich portion of the UO_2–ZrO_2–CaO system at 1700°C or higher and a single phase, face centered cubic solid solution was obtained by firing UO_2–CeO_2 compositions of up to 21 mole % UO_2 in air. (P.G.C.)

41114 (JUL-516-RW) BEITRAG ZUM SYSTEM UC–ZrC–C. (Report on the System UC–ZrC–C). Inanc, Oezel (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Feb. 1968. 125p. (In German). Dep.

In order to investigate the phase field distribution of the UC–ZrC–C system, the boundary systems Zr–C and U–C were studied. The phase width of the Zr carbide was determined by metallographic, roentgenographic, and electron beam microprobe methods. The results showed that the homogeneity range of the Zr carbide extends from 38.4 at.% C to 50.0 at.% C. In the homogeneity range, the lattice constant increases with increasing oxygen content up to 46.14% carbon and then with additional carbon the lattice constants decrease. The lattice constants of molten uranium monocarbide decreases below 50.0 at.% C with decreasing carbon concentration passes through a minimum, and then begins to rise. The minimum was described by homogenation annealing. In samples with more than 50.0 at.% C, the lattice constants of the uranium monocarbide remains constant, independent of the heat treatment and the composition. The uranium solubility in uranium monocarbide was determined. The lattice constants of the (U,Zr)C mixed crystals of molten and annealed samples were determined. The variation of the lattice constants as a function of the composition shows a slight negative deviation from the Vegard rule. The limits of the phase widths of the (U,Zr)C mixed crystals begins in pure ZrC with 38.4 at.% C. It increases sharply with increasing uranium content up 47.0 at.% C in order to remain constant up to pure UC. (J.S.R.)

41115 (ORNL-3515) CORRELATION OF COMPOSITION AND HEAT-TREATMENT WITH THE MICROSTRUCTURES OF URANIUM CARBIDES. Sears, Mildred Bradley; Gray, Robert J.; Ferris, Leslie M.; Leslie, B. C. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 115p. Dep. CFSTI.

Optical photomicrographs, at magnifications of 250× and 1000×, of 78 different arc-cast and heat-treated uranium carbide specimens are presented. Specimens with total-C/U atom ratios ranging from 0.4 to 2.4 (2 to 11 wt % carbon) are included; however, the major emphasis is on the monocarbide-dicarbide, monocarbide-sesquicarbide, and sesquicarbide-dicarbide regions of the phase diagram. The phases present were identified by X-ray diffraction analysis of the specimens at room temperature and, in many instances, were further confirmed by determining the products of hydrolysis. The specimens were analyzed for uranium, total carbon, free carbon, oxygen, nitrogen, and tungsten to provide as complete a characterization as possible. (auth)

41116 (SGAE-M-17/1968) ROENTGENOGRAPHISCHE ANISOTROPIEBESTIMMUNG AN PYROKOHLENSTOFF. (Roentgenographic Determination of Anisotropy in Pyrolytic Graphite). Maerkl, H.; Koss, P.; Bruneder, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Metallurgie). Apr. 1968. 19p. (In German). Dep.

The measurement of the anisotropy factor of pyrolytic graphite yields an important measurement number for assumptions on the behavior of particles coated with pyrolytic carbon under reactor conditions. Various methods therefore for the measurement of the anisotropy factor were developed. The method described using a texture goniometer is characterized by the fact that it is very simple and can easily be automated. The method can also be applied to the anisotropy or texture determination of other materials. The dimension of the sample necessary offers a wide field of application possibilities since probes of some 100-μ width and several mm lengths can be taken without much effort from larger materials and can be measured by this method. The calculation of the absorption coefficient is illustrated in the appendix. (tr-auth)

41117 OXYGEN-ION DIFFUSIVITY IN HYPOSTOICHIOMETRIC ZIRCONIUM DIOXIDE. Rosa, C. J.; Hagel, W. C. (Univ. of Denver). J. Nucl. Mater., 27: 12-20(July 1968).

Based on calculations applicable to unidirectional volume diffusion in two-phase systems it is possible to evaluate the diffusion coefficients for oxygen ions in zirconium dioxide. These calculations require the knowledge of both the thicknesses of the oxide scale and of oxygen diffusion coefficients in zirconium metal. The results conform to the relationship $D = 2.88 \times 10^{-4}$ exp $(-28{,}400/RT)cm^2/sec$ for diffusion of oxygen in hypostoichiometric zirconium oxide within the temperature range of 600 to 850°C. (auth)

41118 POROSIMETER FOR DETERMINING THE SIZES OF FLAWS IN ZIRCONIA OR OTHER INSULATING FILMS "IN SITU". Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 27: 1–11(July 1968).

For determining the sizes of pores and cracks in oxide films on zirconium alloys a mercury porosimeter was developed. By plotting the resistive component of the impedance of the oxide film as a function of pressure (up to 10^5 psi) for a specimen im-

mersed in mercury it was possible to determine the size distribution of flaws in the oxide. Evidence is presented to show that the defects detected in the oxide film are real and were not created by the conditions in the porosimeter. The smallest flaws identifiable in the porosimeter are below the resolution of a conventional two-stage electron microscope replica technique. (auth)

41119 PHASE EQUILIBRIA IN TERNARY SYSTEMS CONTAINING ZIRCONIA AND SILICA. I. THE SYSTEM CaO–ZrO_2–SiO_2. Qureshi, M. H.; Brett, N. H. (Univ. of Sheffield, Eng.). Trans. Brit. Ceram. Soc., 67: 205-19(June 1968).

The phase equilibrium relationships in the ternary system CaO–ZrO_2–SiO_2 were re-examined by the usual quenching techniques in air followed by ceramographic and x-ray examination. These studies revealed the presence of a primary-phase field of zircon and a two-liquid immiscibility gap within the partial system $CaSiO_3$–ZrO_2–SiO_2. In the partial system Ca_2SiO_4–ZrO_2–CaO, the lowest liquidus temperature was 1925 ± 25°C and occurred at the ternary eutectic composition formed by Ca_2SiO_4, $CaZrO_3$, and $Ca_3Si_2O_7$. The compositions of 11 ternary invariant points are reported and the primary-phase fields of 10 compounds are outlined. The diagram is of technological interest, since composition regions of high refractoriness are shown to exist. (auth) (UK)

41120 THERMODYNAMIC PROPERTIES OF NIOBIUM CARBIDES AND NITRIDES IN STEELS. Mori, Toshisada (Kyoto Univ.); Yamaguchi, Ko. Tetsu To Hagane, 54: 763-76(June (1968). (In Japanese).

The crystallographic structure and the chemical composition of precipitated δ-phase, δ′-phase and ε-phase were extensively investigated on those specimens which had been prepared from vacuum melted high-purity Fe–Nb–C, Fe–Nb–N and Fe–Nb–C–N alloys containing niobium up to 0.95%. The specimens were solution treated at 1300 or 1350°C for 2 hr, and were again quenched into water after long time holding at respective temperatures of 1000 to 1300°C. The quantitative determination of soluble-niobium, -carbon and -nitrogen was also investigated in order to calculate the solubility products of niobium-carbide and austenite. It was found that the chemical composition of pure δ-niobium-carbide precipitates was determined to be $NbC_{0.87}$ though the precipitated δ-phase was not pure carbide but carbonitride even in the Fe–Nb–C alloys containing little nitrogen. The precipitated δ′-nitride in Fe–Nb–N alloys containing little carbon was substantially carbonitride containing a little amount of carbon, while the precipitated ε-nitride was estimated to be a pure niobium-nitride NbN. The solubility products of niobium-carbide and -nitride in austenitie was given respectively by the following equations; $\log [\%Nb][\%Cr]^{0.87} = -7{,}700/T + 3.18$; $\log [\%Nb][\%N] = -10{,}150/T + 3.79$. It has been proved that oxygen has the stronger affinity to niobium than carbon and nitrogen in austenite. The preferential precipitation of a little amount of tapiolite [$(Fe,Nb)O_2$ or $FeO \cdot Nb_2O_5$] was recognized in all specimens. (NSA of Japan)

41121 NEUTRON DIFFRACTION STUDY OF THE CRYSTAL STRUCTURES OF ETA-PHASE IRON–TUNGSTEN CARBIDES. Bojarski, Zbigniew; Leciejewicz, Janusz. Arch. Hutn., 12: 255-63(1967). (In Polish).

The crystal structures of η-type iron tungsten carbides Fe_3W_3C and Fe_6W_6C were investigated by neutron diffraction using polycrystalline samples. The space group Fd3m and the lattice sites of the metallic atoms as reported earlier in x-ray studies have been confirmed. In both structures the carbon atoms occupy the centers of octahedral holes built of tungsten atoms only. In the case of Fe_3W_3C the CW_6 octahedra are slightly deformed. They are linked by common edges forming a framework of interconnected chains which are extending in the [110] and [1$\bar{1}$0] directions. In Fe_3W_3C the W–C distance within the CW_6 octahedron is 2.119 Å indicating a strong chemical interaction. In the crystal lattice of Fe_6W_6C isolated perfect CW_6 octahedra are present. The W–C distance is 2.153 Å. In Fe_3W_3C 6 iron atoms situated at the corners of an octahedron with Fe–C distance of 3.350 Å are surrounding each carbon atom. There are 4 iron atoms at the corners of a tetrahedron in Fe_6W_6C surrounding each carbon atom with the Fe–C distance of 3.213 Å. For both carbides the atomic parameters and isotropic Debye-Waller factors were refined by the method of least-squares using the GIER computer. (auth)

41122 HIGH-TEMPERATURE STRUCTURE OF PLUTONIUM DICARBIDE. Harper, E. A.; Hedger, H. J.; Dalton, J. T. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 219: 151(July 13, 1968).

The Pu–C system is briefly described along with phase relationships in the UC_2–PuC_2 system. A high temperature diffractometer was employed, attached to a conventional x-ray goniometer, using Cu K_α radiation. The sample was heated in the diffractometer to an indicated surface temperature of 1.500°C, at a vacuum of $< 5 \times 10^{-6}$ torr; this gave only a Pu_2C_3 phase. When the temperature was increased to 1.710°C in a helium atmosphere the line intensity of the Pu_2C_3 diminished and a new set of diffraction peaks appeared, attributed to PuC_2. The structure of the PuC_2 was found to be fcc. Results suggested that the reaction Pu_2C_3 + C proceeds slowly at 1.710°C. The lattice parameter of the PuC_2 was measured as 5.70 ± 0.01 Å. It is considered that the tetragonal cell previously observed was a metastable phase formed by a martensitic transformation on quenching fcc PuC_2. (UK)

41123 SOLUBILITY AND PHASE EQUILIBRIUM IN THE SYSTEMS Sm_2O_3–SrO–B_2O_3 AND Eu_2O_3–SrO–B_2O_3 AT 1100°C. Dzhurinskii, B. F.; Tananaev, I. V.; Aliev, O. A. (Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 941-7(June 1968). (In Russian).

By the method of isothermal saturation, phase equilibria in the system Sm_2O_3–SrO–B_2O_3 and in part of the system Eu_2O_3–SrO–B_2O_3 were studied at 1100°C. The ranges of existence of the solid phases $SmBO_3$, $Sm(BO_2)_3$, $Sm_2Sr_3(BO_3)_4$, and $Sr_2B_2O_5$ were characterized. The compounds $Sm(BO_2)_3$, $Sm_2Sr_3(BO_3)_4$, and $Eu(BO_2)_3$ were obtained in the crystalline state. The solubility of the oxides of La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, and Yb in melts of the monotectic compositions of the system Ln_2O_3–SrO–B_2O_3 was established at 1100°C. (tr-auth)

Radiation Effects

Refer also to abstract 42200.

41124 (BNWL-SA-1674) TRANSIENT IRRADIATION EXPERIMENTS WITH VIBRATIONALLY COMPACTED UO_2 FUEL RODS IN TREAT. Gulley, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Armstrong, D. R.; Harrison, L. J. (Argonne National Lab., Ill.). June 4, 1968. Contract AT-(45-1)-1830. 14p. (CONF-680601-22). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Behavior of Zircaloy-2 clad, vibrationally compacted UO_2 fuel rods under transient radiation in the Transient Reactor Test Facility (TREAT) is reported. (P.G.C.)

41125 (BNWL-SA-1679) IN-REACTOR SINTERED FUEL. Horn, Glen R.; Gulley, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 6, 1968. Contract AT-(45-1)-1830. 15p. (CONF-680601-23). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

An experimental seven-rod fuel element cluster containing initially non-sintered low-density pellets of a mixture of fused and ceramic grade UO_2 was fabricated and irradiated in the ETR to demonstrate feasibility of operating such fuel rods. Preliminary results prompt further experiments with this less expensive fuel. (P.G.C.)

41126 (CEA-R-3446) OBSERVATIONS ON THE LIBERATION OF BROMINE AND IODINE FROM UO_2 DURING IRRADIATION. Chenebault, Pierre; Hairion, Jean-Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 1968. 27p. (In French). (CONF-670950-3). Dep.

From Nuclear Division Fall Meeting, Urbana, Ill.

UO_2 samples have been irradiated isothermally between 150°C and 1800°C; the krypton and xenon released are swept from the samples, collected out-of-pile in traps and analyzed. A study of the kinetics suggests that, for a given temperature, the emission of the halogens (radioactive parents of the rare gases) is the most important process. By using previously irradiated samples containing high concentrations of some gaseous isotopes, it is observed that the release of xenon and krypton is not too dependent on the concentrations of the gases in the solid; it is concluded that the rare gas release during irradiation is due mainly to the migration of the halogens. (auth)

41127 (CEND-2936-335, IV.1-41) IRRADIATION PROGRAM. (Combustion Engineering, Inc., Windsor, Conn.).

Data are reported on the performance of reactor fuels containing UO_2 in solid solution with CaO-stabilized zirconia and ceria at fission burnups of 40, 55, and 70% of the U-235 atoms at temperatures just below the melting points. Fuel parameters are tabulated, summaries of burnup data from nuclear mockup experiments are shown, and design of fuel capsules and components are illustrated. (P.G.C.)

41128 (CEND-2936-335, V.1-25) POST-IRRADIATION EXAMINATION. (Combustion Engineering, Inc., Windsor, Conn.).

A detailed report of post-irradiation examinations conducted on CeO_2 base and ZrO_2 base UO_2 fuel elements, including visual examination of irradiated capsules and specimens, burnup analysis,

fission gas release, dimensional measurements and sectioning plans, metallography, autoradiography, and x-ray diffraction data, and results of corrosion tests. (P.G.C.)

41129 (CEND-2936-335, VI.1-7) ANALYSES OF POST-IRRADIATION DATA. (Combustion Engineering, Inc., Windsor, Conn.).

A discussion and analysis of thermal conductivity measurements, fission gas release, grain growth, and dimensional changes in irradiated ceria base and zirconia base UO_2 systems as they affect performance of these fuels. (P.G.C.)

41130 (CONF-670967-1) IRRADIATION OF FUEL ELEMENTS WITH CENTRAL TEMPERATURES ABOVE THE MELTING POINT OF UO_2. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). [1967]. 19p. (In German). Dep. CFSTI.

From Internal Colloquium of the Institute for Reactor Materials, Julich, Germany.

The irradiation experiments with sintered pellet rods are described and discussed. The most important results of the post-irradiation examination, dimensional changes, fission gas release, and microstructural changes are outlined and evaluated. (auth)

41131 (GEAP-5598) ZIRCALOY-CLAD UO_2 FUEL ROD EVALUATION PROGRAM. Quarterly Progress Report No. 1, November 1967-January 1968. Megerth, F. H. (comp.) (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Mar. 1968. Contract AT(04-3)-189. 39p. Dep. CFSTI.

Zircaloy-2 clad UO_2 fuel rods from the first shutdown of the Vallecitos Boiling Water Reactor (VBWR) were incorporated in a special assembly and inserted in the Dresden Reactor for additional irradiation to determine the earliest possible time for the fuel to achieve average burnup of at least 6×10^{20} fissions/cc (20,000 MWd/tU). Results of examinations of 10 of the 88 additionally irradiated rods are reported. (P.G.C.)

41132 (KFK-745) UNTERSUCHUNG VON STRAHLENSCHAEDEN IN ZrO_2, ZrN, ZrC, UND UO_2, UN, UC DURCH ROENTGENSTRAHLENBEUGUNG. (Investigation of Radiation Damage in ZrO_2, ZrN, ZrC, and UO_2, UN, UC through X-Ray Diffraction). Dienst, W.; Brucklacher, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Mar. 1968. 25p. (In German). (EUR-3711). Dep.

Powder samples of ZrO_2 (cubic stabilized), ZrN, ZrC, and UN, UC were irradiated in the Karlsruhe reactor FR-2 at temperatures below 150°C up to integrated fast neutron fluxes of 2.5×10^{19} n/cm^2 (E > 100 keV) or up to fission densities of 6.4×10^{18} fission/cm^2. The changes in the lattice constants caused by irradiation ($\Delta a \approx 1$ to 5×10^{-3}) and the x-ray reflection widths were measured with an x-ray counter goniometer for radioactive samples. The difference in the $\Delta a/a$ saturation pattern for the Zr compound can be brought in the relationship so that the resistance with respect to the formation of large interstitial lattice atom clusters increases in the transition from extensively ionic to covalent compounds. The results for UN, UC were compared with the literature data for UO_2. In all cases, after the initial saturation of the lattice constant increases, a transient decrease occurs followed by a later rise of the lattice constants leading to the highest attained fission density. In the first saturation of the lattice constant increase, a strong x-ray reflection broadening occurs which is probably due to the formation of large interstitial atom clusters. All radiation effects are sharply emphasized in the UN samples. These results suggest that the mobility of the point defects in the lattice of the uranium compounds decreases in the sequence $UO_2 \rightarrow UC \rightarrow UN$. (tr-auth)

41133 (WAPD-TM-596) EVALUATION OF THE IRRADIATION BEHAVIOR OF A ZIRCALOY-4 CLAD ROD CONTAINING LOW DENSITY UO_2 FUEL PELLETS (LWBR/LSBR DEVELOPMENT PROGRAM). McCauley, J. E.; Patterson, P. W.; Daniel, R. C.; Meieran, H. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1968. Contract AT-11-1-GEN-14. 75p. Dep. CFSTI.

A Zircaloy-4-sheathed, rod type fuel element containing low density (~81.4% of theoretical) UO_2 fuel pellets was irradiated to a peak average depletion of 13.5×10^{20} fissions per cubic centimeter of fully dense fuel at an estimated peak pellet temperature of 2710°F. The specimen was removed from the reactor at approximately 50% of design lifetime in order to evaluate the fuel and cladding irradiation-induced changes in the absence of the complicating effects usually associated with in-reactor specimen failure. Extensive dimensional and metallographic evaluation indicated that at that point in lifetime, the fuel swelling was totally accommodated within the void internal to the oxide pellet. Within measurement error, no external dimensional changes were observed that could be related to fuel swelling. Corrosion weight gain and hydrogen uptake in the cladding were in agreement with behavior anticipated from out-of-pile, static autoclave tests. Reasonable agreement was obtained between measurements and calculations of fuel and cladding deformation as a function of irradiation lifetime. These calculations were performed with the analysis method incorporated in the CYGRO-2 digital program. The material properties and other input parameters and assumptions are presented in detail. (auth)

41134 EVOLUTION OF THE STRUCTURE OF GRAPHITE, DETERMINED BY MICROSCOPIC EXAMINATION AFTER THERMAL OXIDATION. Lang, Francois Michel; Gilles, Pierre; Kern, Suzanne; Maire, Philippe (CEN de Saclay, Gif-sur-Yvette, France). J. Chim. Phys., 65: 580-2(1968). (In French).

The evolution of the structure of graphite irradiated under vacuum to a dose of 10^{20} nvt was examined with an electron microscope by the intermediary of replicas on the ⟨000 1⟩ plane. The surface of the irradiated sample is similar to that of the sample graphite, with however perturbed regions. After oxidation of the irradiated samples a multitude of small holes with round boundaries are formed. An anneal of 8 hr at 1000°C is not sufficient to restore the graphite, but a 2 hr treatment at temperatures above 2500°C restores a crystalline state almost analogous to that before irradiation. The structure evolution after attack by atomic oxygen was also studied. The oxidation leads rapidly to the formation of hexagons, which are smaller and more numerous than those obtained from the oxidized sample graphite. The cleavage of graphite attacked with atomic oxygen showed that the atomic O did not affect the graphite in depth. (J.S.R.)

41135 EFFECT OF IRRADIATION ON THE MICROSTRUCTURE OF SWAGED UO_2. Ishii, Bumpei; Takahashi, Shuichiro (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 292-7(June 1968).

A study was made of the microstructure of swaged UO_2, irradiated to a burnup of 3,000 MWd/t-U at an estimated centerline temperature of 1,400°C. In the peripheral zones of the specimen near the cladding, evidence was observed of sintering of the UO_2 particles by irradiation even at comparatively low temperatures (about 300 ~ 400°C). Tracks of fission product fragments were observed at the inner wall surface of cracks in the specimen. The width of the tracks is seen to be larger than observed on thin films and on sintered UO_2. Mixed phases of UO_2 and fission products precipitated in the interior of crystal grains, observed in the form of hillocks left unetched, were surmounted by several sprouts of substances still more chemically stable. Mixed phases of UO_2 and fission products were precipitated on the inner wall surface of the cracks and appeared upon etching as stepped protuberances of irregular contours. A comparison between the microstructures of swaged UO_2 and sintered UO_2 irradiated under the similar conditions is discussed. (auth)

41136 FISSION-GAS RELEASE FROM FISSIONING UO_2 AT TEMPERATURES CONDUCIVE TO GRAIN GROWTH (AROUND 2,000°C). Doi, Akira; Hayashi, Hiroshi; Ohsawa, Yasuo; Inoue, Kiyoshi (Hitachi Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 5: 313-15(June 1968).

Data and information obtained in preliminary out-of-pile tests are presented. Work is in progress on in-pile fission gas release to evaluate the effects of irradiation temperature and UO_2 grain size. The in-pile facility in the Hitachi Training Reactor is described. (J.R.D.)

41137 ORIENTATION OF COPPER OXIDE COATING DURING ION BOMBARDMENT. Meier, M.; Gaimann, P.; Trilia, Zh. Zh. Rost Kristallov, Akad. Nauk SSSR, Inst. Kristallogr., 8: 146-50(1968). (In Russian).

From 7th International Congress of Crystal Growth, Moscow.

The massive copper monocrystal face(100) was oxidized by bombardment with 10 keV oxygen ions at room temperature. The oxide is, ordinarily, oriented so that the copper and oxide lattices are parallel. The orientation depends on the conditions of oxygen ion penetration through copper lattice. The thickness and coating defects were examined after separation and the mechanism of oxygen ion penetration through copper was analyzed. (R.V.J.)

Plastics and Other Materials

Refer also to abstracts 41004, 42388, and 42392.

41138 DURABILITY OF CONCRETE CONSTRUCTION. Woods, Hubert. American Concrete Institute Monograph Series, No. 4. Detroit, American Concrete Inst. Ames, Iowa, Iowa State University Press, 1968. 199p.

The durability of concrete as a construction material is discussed. Data on the following aspects of concrete are presented:

the nature of concrete; freezing and thawing; reactive aggregates; steel and other embedded materials in concrete; chemical effects on concrete; and other aspects of concrete durability. The use of concrete in radiation shielding is briefly described. (R.C.K.)

41139 RADIOACTIVE FLUOPHOSPHATE GLASS COMPOSITION. Sun, Kuan-han; Chen, Chin-tang; Shan, Yueh (to Westinghouse Electric Corp.). U. S. Patent 3,373,116. Mar. 12, 1968. Filed Mar. 15, 1965.

A radioactive fluorophosphate glass containing at least 40 wt % U is described. The glass melts above 800°C and also contains 34 to 75 wt % of a phosphate of Al or Be and 15 to 43 wt % of at least one fluoride or oxide selected from the group consisting of a univalent metal fluoride, a bivalent metal oxide, and B oxide in addition to the uranium oxide or fluoride. The uranium compound may be replaced by a Th or Pu fluoride or oxide. The resulting glass contains a sufficient quantity of fissionable material to support fission in a reactor. A phase diagram for a specific glass composition is given. (B.L.M.)

41140 THE MECHANISM AND KINETICS OF THE GRAPHITE–OXYGEN REACTION. Parkin, A. Newcastle upon Tyne, Eng., Univ. of Newcastle upon Tyne, 1967. 168p.

Thesis.

Neutron irradiation of graphite increased the rate of reaction with oxygen, but to a rather small extent. The unpaired electron centers (measured by the technique of electron spin resonance) while not themselves sites of high reactivity, proved useful as a monitor of the damage present in an irradiated sample. Halogens were adsorbed at structural defects and found to act either as inhibitors or catalysts, depending on their concentration and the sites on the graphite on which they were situated. The reactivity results were interpreted by postulating the existence of two opposing effects: the first was a direct poisoning of active sites by halogen, causing a reduction of rate; the second was a limited electronic effect of surface adsorbed halogen, which caused catalysis by destabilizing the adjacent surface oxide. This was particularly apparent in that fraction of surface carbon atoms covered by two oxygen atoms. The interlamellar halogen species appears to have little or no effect on the reactivity. When an interlamellar species was formed with bromine, the conduction resonance signal of an unirradiated graphite was completely removed. For a specimen irradiated in an atmosphere of carbon dioxide, the ESR signal fell with increasing halogen concentration. Potassium was found to act as a very efficient catalyst for the oxidation of graphite, probably by increasing the case of chemisorption of oxygen on to the surface of the sample. The rate initially increased practically linearly with metal content, but eventually began to saturate. Further additions of potassium, the bulk of which was presumably interlamellar material, had little effect on the reactivity. The mechanism of the graphite-oxygen reaction was investigated using a 50–50 mixture of $^{16-16}O_2$ and $^{18-18}O_2$. The oxygen in a product carbon dioxide molecule originated from two different oxygen molecules. This technique also showed that the mechanism of the reaction of oxygen with a graphite, whether untreated, halogenated, or potassium-treated, was essentially the same, and substantiated the hypothesis for the roles played by any particular impurity in the reaction. 259 references. (auth) (UK)

41141 GAMMA RADIATION INFLUENCE ON THE ADHESION OF EPOXY COMPOUNDS TO METALS. Rizaev, N. U.; Shipilevskii, B. A.; Okun, A. G.; Ul'masov, T. U. Plast. Massy, No. 7, 43-4(1968). (In Russian).

Data obtained revealed that γ irradiation improved the durability of epoxy coatings by creating uniformly strong adhesive seams and coatings. (R.V.J.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 40409, 41338, 41386, 41387, 41389, 41487–41489, 41501, and 41791.

41142 (NP-17529) SIMULTANEOUS OBSERVATIONS OF H α AND THE K-LINE OF Ca II IN THE SOLAR SPECTRUM. Report No. 24. Engvold, Oddbjoern (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 1967. 13p. Dep.

A simple method for simultaneous observations of the K line of Ca II and the Hα is described. It is shown that the same technique may easily be applied for other strong lines in the solar spectrum. (auth)

41143 (NP-17530) ON COORDINATE SYSTEMS FOR DESCRIBING THE POSITION OF SOLAR ATMOSPHERIC FEATURES. Report No. 25. Haugen, Einar (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 1968. 27p. Dep.

The formulae for transformation from a set of observable coordinates of solar features to two sets of "spotcentric" coordinates are given. A set of approximate formulae are given for the same coordinate-transformations. The values of the two sets of exact coordinates were computed for a grid of observed-coordinate values, and compared with the corresponding values given by the approximate formulae. (auth)

41144 MODEL FOR THE EVOLUTION OF EXTENDED RADIO SOURCES. Rees, M. J. (Cambridge Univ., Eng.); Setti, G. Nature (London), 219: 127-31(July 13, 1968).

Large radio sources are influenced by the intergalactic medium and the cosmic black-body radiation, both of which are limited with red shift in a predictable way. The type of source evolution implied by the radio data can be fitted by a simple model. This topic links with the x-ray background and the intergalactic cosmic-ray density. (auth) (UK)

41145 PULSAR CONDITION IN WHITE DWARF STARS. Israel, W. (Dublin Inst. Advanced Studies). Nature (London), 218: 1235-6(June 29, 1968).

It has been proposed that a pulsar is a neutron star at the critical mass limit for gravitational instability, and that neutron star pulsars could have evolved from Type-II supernova remnants, the masses of which remain somewhat above critical mass, by violent gravitational oscillations, with emission of gas and relativistic baryons. In such cases the critical mass limit is approached from above. The process of accretion, however, offers a mechanism by which an underluminous white dwarf star might approach the critical mass from below. The possibility is considered that the pulsar condition might be characteristic of a sizable proportion of those population-II stars the evolution of which can be significantly affected by accretion. The star will pass into a pulsar condition, gaining temporary reprieves from instability by lifting off its nondegenerate outer shell (highly distended), with small velocity, by a series of pulses, which also sweep away much of the accreting material. The pulses are generated in the deeper layers by momentary instabilities caused by descent of the shell on to the surface. If a pulse energy of 10^{35} ergs is assumed, the initial pulse (before passage through the envelope) will be in the form of soft x rays. Two alternatives then arise—first, if the shell is opaque to x rays the pulses will be degraded to near optical frequencies and the pulsed character of the emission will be visible as a smoothed-out light variation, the period then being simply the time required for a pulse to transverse the envelope. The second alternative—an envelope transparent to x rays—may arise with very close binaries, where tidal and rotational effects may concentrate the shell into an equatorial disk, and x-ray emission should then be directly observable. The chief new aspect here is the possibility of a pulsed character for the x-ray emission. Circumstances are considered in which the shock mechanism envisaged for controlling the accretion breaks down, leading ultimately to powerful nuclear reactions in the deeper interior, with expulsion of perhaps 10^{28} to 10^{30} g of material. It is stated that this picture of the initial stages of a nova outburst reproduces many of the observed features. The implications of the hypothesis for the large-scale dynamics of galaxies are briefly considered. (UK)

41146 COLLAPSE AND ANTICOLLAPSE IN SUPERNOVAE, IN RADIOGALAXIES, IN QUASARS, AND IN SUPERCLUSTERS OF GALAXIES. Kalitsin, Nikola St. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 233-54(1968).

The source of electrons with very high energies and of vast regions with magnetic fields at the center of supernovas, radiogalaxies, and quasars is considered. A five-dimensional theory of relativity is presented according to which a body can fall in finite time (measured by a far away observer) to Schwarzschild's sphere. Based on this theory, the suggestion is made that in the event of gravitational collapse of a massive object, the masses falling to the center of the collapse collide in the center with relativistic velocities and rebound elastically with similar velocities in the opposite direction (anticollapse). In the case of inelastic collapse, high pressures, temperatures, and densities can result in explosions that cause expansion of the collided masses. This expanding matter collides with matter still falling to the center and forms condensation nuclei. The possibility that these nuclei can become stellar centers suggests an explanation of the formation of galactic structures. (A.G.W.)

41147 MASS AND ENERGY BALANCE OF MASSIVE AND SUPERMASSIVE STARS. Nedyalkov, Ivan. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 277-82(1968). (In Russian).

An assumption is made that the quasars and the nuclei of the Seyfert galaxies contain one or more massive and supermassive stars, which exchange intensively mass and energy with the surrounding medium. The mass M and the energy E of these stars are considered as variable. The mass decreases because of outgoing gas and increases via accretion, provided the latter is considerable. The energy increase is due to the energy flow with the accreting matter and the decrease is due to the outflow with the masses thrown out and the electromagnetic radiation. The mass and energy balance is expressed by equations. If suitable observation data are available these equations could be used to estimate some of the quasar parameters. A hypothesis is proposed that the jets observed in some quasars and Seyfert galaxies come out from their constituent massive and supermassive stars rotating with considerable angular velocity. (auth)

41148 TIME AUTOCORRELATION OF THE SUNSPOT SURFACES. Gabrovski, Iv.; Gadzhokov, V.; Kalinkov, M. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 283-92(1968). (In Russian).

The results of calculation of autocorrelation functions for sunspot surfaces corresponding to the synodic rotations (surfaces related to the north and south sun hemisphere and to the total sphere) are presented. The duration of the 11-year cycle is determined on the basis of the first maxima of the autocorrelation functions. An expression for approximation of the autocorrelation functions is proposed. (auth)

41149 STRUCTURE OF POLYTROPES WITH PURELY TOROIDAL MAGNETIC FIELDS. Sinha, Narendra K. (Monash Univ., Clayton, Victoria). Aust. J. Phys., 21: 283-91(June 1968).

The influence of a purely toroidal magnetic field upon the structure of a polytrope was investigated and the first-order perturbations in the density distribution, the geometry of the boundary, and the mass–radius relation were obtained. (auth)

41150 EQUILIBRIUM POLOIDAL MAGNETIC FIELDS IN ROTATING STARS. Davies, G. F. (Monash Univ., Clayton, Victoria). Aust. J. Phys., 21: 293-305(June 1968).

Solutions are presented for equilibrium poloidal dipole magnetic fields in a uniformly rotating upper main-sequence star with no meridional circulation currents. An upper limit is found for the ratio of kinetic energy of rotation to the magnetic field energy. The perturbations to the structure of the star are also given. (auth)

41151 THE LINEAR POLARIZATION OF RADIATION FROM JUPITER AT 6 CM WAVELENGTH. Morris, D.; Whiteoak, J. B.; Tonking, F. (Commonwealth Scientific and Industrial Research Organization, Epping, New South Wales). Aust. J. Phys., 21: 337-40(June 1968).

At a wavelength of 6 cm the degree of linear polarization of the radiation from Jupiter is 0.076 ± 0.002. The variation of the direction of polarization with longitude of the central meridian is consistent with the increased period of rotation determined by Komesaroff and McCulloch (1967). There is evidence of an asymmetrical beaming of the nonthermal radiation with longitude in addition to the latitude asymmetry that was detected previously by Roberts and Komesaroff (1965). The mean flux density normalized to a distance of 4.04 AU is 10.7 ± 0.2 f.u. The small nonthermal contribution (3.7 f.u.) is further evidence for a high frequency cutoff in the synchrotron radiation; the thermal component corresponds to a brightness temperature of about 250°K. (auth)

41152 THE SOLAR WIND AND JOVIAN DECAMETRIC RADIO EMISSION. Slee, O. B.; Higgins, C. S. (Commonwealth

Scientific and Industrial Research Organization, Epping, New South Wales). Aust. J. Phys., 21: 341-68(June 1968).

Spaced-receiver observations of the 19.7 MHz radio emission from Jupiter during 1963 and 1964 demonstrate that many of the so-called bursts with quasi periods of 1 to 10 sec are caused by the sweeping of an interplanetary diffraction pattern across the receiver by the motion of scattering irregularities in the solar wind. Measurements made on these scintillations include arrival time differences at spaced receivers, scintillation rate, angular position scintillation, and the width of the scattered angular power spectrum. The derived properties of the scattering irregularities are as follows: (1) the solar wind is radially directed with respect to the Sun and possesses an average velocity $V_0 \sim 600$ km sec^{-1}; (2) r.m.s. derivations in the magnitude and direction of V_0, averaged over considerable path lengths through interplanetary space, are less than 20% and 5°, respectively; (3) the scale size of the irregularities in electron density is approximately 150 km; (4) the scattering is strong at 19.7 MHz for all directions in the ecliptic plane; the r.m.s. phase modulation varies from about 1 rad near opposition to about 11 rad at an elongation of 20°; (5) the conclusions in (3) and (4) are consistent with an r.m.s. electron density that varies with heliocentric distance R (A U) according to the relation $\{(\Delta N)^2\}^{\frac{1}{2}} \sim 0 \cdot 2\ R^{-2}$ electrons cm^{-3}; and (6) the irregularities in electron density with dimensions of hundreds of kilometers are relatively weak (~10%) in comparison with the average electron density. Theoretical restrictions on source size are used to derive an upper limit of ~0.6 sec of arc to the angular diameter of the decametric source on Jupiter. It is shown that the intensity scintillations are significantly reduced when the line of sight passes within 60° of the Sun; if this is due to the finite source size, a lower limit of ~0.1 sec of arc can be assigned to the source diameter. (auth)

41153 CATALOGUE OF GALACTIC RADIO SOURCES. Kesteven, M. J. L. (Univ. of Sydney). Aust. J. Phys., 21: 369-76(June 1968).

The results of a survey of radio sources in the galactic plane in the longitude range 180 to 40° with the 1-mile Molonglo Cross telescope at 408 MHz are presented. The methods of observation and reduction are described briefly. The catalogue lists the position, flux density, size, and spectral index for 80 sources. (auth)

41154 THE PARKES CATALOGUE OF RADIO SOURCES: DECLINATION ZONE +20 TO +27°. Shimmins, A. J.; Day, G. A. (Commonwealth Scientific and Industrial Research Organization, Epping, New South Wales). Aust. J. Phys., 21: 377-403(June 1968).

Details are given of 397 radio sources between declinations +20° and +27° which were compiled from a finding survey made at 635 MHz with the 210 ft reflector at the Australian National Radio Astronomy Observatory, Parkes, N.S.W. The survey covers an area of 0.703 steradian but is incomplete in two regions within ±10° of the galactic equator. Additional measurements of flux densities and positions were made at 1410 and 2650 MHz. Some discussions on spectra, source counts, and source identifications are included, and a comparison is made between this survey and other published catalogues covering the same region. (auth)

41155 INTERPRETATION OF THE RADIO ROTATION PERIOD OF JUPITER IN TERMS OF THE CYCLOTRON THEORY. McCulloch, P. M. (Univ. of Tasmania, Hobart). Aust. J. Phys., 21: 409-13(June 1968).

Since 1961 the most intense source of Jovian decametric emission has drifted with respect to system III longitude by about +10° per year. Interpreted as a change in the rotation rate, this would imply that the period increased by approximately 1.1 sec around 1960. An interpretation of the radio rotation period is given in terms of the cyclotron theory. (W.D.M.)

41156 GAMMA RADIATION FROM CELESTIAL SOURCES. Haymes, Robert C. (Rice Univ., Houston, Tex.). Res. Rev. (Office Aerosp. Res.), 7: No. 2, 1-2(Feb. 1968).

Investigations were made of the gamma-ray spectra from the Crab Nebulae and the Cygnus constellation using a balloon-borne directional scintillation counter. Power law and exponential fits are given for the gamma radiation spectrum from each of the two sources. (TSS)

41157 SPATIO-TEMPORAL ANALYSIS OF VELOCITY FIELDS IN THE SOLAR PHOTOSPHERE. Frazier, Edward N. (Univ. of California, Berkeley). Z. Astrophys., 68: 345-56 (1968).

A series of high (spatial) resolution spectrograms were taken of the center of the solar disk at Kitt Peak National Observatory. The spectrograms were taken every 20 seconds for 55 minutes. The Doppler shifts of the absorption lines, as well as the intensity fluctuations, both in the continuum and in the lines, were subjected to a simultaneous spatial and temporal Fourier analysis. The results are displayed in the form of contour lines in the $k-\omega$ plane, or diagnostic diagram. These results clearly show convective overshoot at all levels of the photosphere. They also show that the well-known 5-min oscillations are primarily standing resonant acoustic waves. The "gravity wave" mode was not observed. Arguments are presented suggesting that the oscillations are not formed directly from the "piston action" of a convective cell impinging on the stable photosphere, but rather are formed within the convection zone itself. (auth)

41158 CONVECTIVE INSTABILITIES IN A COMPRESSIBLE ATMOSPHERE. I. THE EFFECT OF MAGNETIC FIELD. Grover, S. D.; Tandon, J. N. (Univ. of Delhi). Z. Astrophys., 68: 357-65(1968).

The effect of a magnetic field on the onset of thermal convection is studied for polytropic weakly ionized atmospheres of late type stars. It is assumed that the layer thickness is small. Systematic expansion of the perturbation equations in terms of layer thickness leads to the lowest order of the equations corresponding to the Boussinesq approximation. The first order equations show that even a very weak field masks the effect of the density variations due to the compressibility of the medium. (auth)

41159 ABSOLUTE PROPER MOTIONS AND SPACE VELOCITIES OF PLANETARY NEBULAE. de Vegt, Chr. (Hamburger Sternwarte, Hamburg). Z. Astrophys., 68: 366-7(1968).

Absolute proper motions and space velocities for 11 planetary nebulae were derived from measurements of AGK 2/3 catalogue plates. (auth)

41160 THE CYGNUS X REGION. III. OBSERVATIONS OF THE NGC 7000 AREA AT DECIMETER WAVELENGTHS. Wendker, H. (Univ. of Illinois, Urbana). Z. Astrophys., 68: 368-79 (1968).

The NGC 7000 area was observed at 610.5, 750, and 1414 MHz. The results are presented in the form of contour maps. It is concluded that the whole area consists of only one extended H II region which has nearly circular symmetry and a diameter of about 3°. At least 18 local maxima are embedded within this cloud. An average electron density of 9 cm^{-3} is derived for an assumed distance of 1000 pc. The total mass is about 18,000 solar masses. (auth)

41161 MEASUREMENT AND ANALYSIS OF POLARIZATION OF STARLIGHT IN CASSIOPEIA. Schmidt, Thomas (Boyden Observatory, Bloemfontein, South Africa). Z. Astrophys., 68: 380-99(1968). (In German).

The polarization of 143 field stars (90 of them measured at Heidelberg) in the Milky Way at $127.0° < l^{II} < 133.5°$ and $-2.2° < b^{II} < +2.7°$ was analyzed. This field is located nearly perpendicular to the direction of the galactic magnetic field and is characterized by uniform interstellar absorption. In the distant region of mean constant absorption ($r > 1.2$ Kpc) no correlation between absorption and polarization was found. 5.5 interstellar polarizing clouds per Kpc, the ratio $(p/A_v) = \alpha_0 = 0.056$ of a single cloud and the standard deviation of the magnetic field direction $\sigma_\phi = 14°$ result from the analysis of the standard deviations of $p/A_v = \alpha$ and the polarization angle Θ. The interpretation of the structure functions $D_p(\varphi)$, $D_\alpha(\varphi)$, $D_\Theta(\varphi)$ and $D_A(\varphi)$ yields a mean effective diameter of a single absorbing and polarizing cloud $\Delta_0 = 1$ to 2 pc. Comparing the different structure functions, it is possible to get information about the internal structure of a single cloud; a total cloud diameter is indicated of approximately 10 pc. From σ_ϕ an interstellar magnetic field strength of $B = 1.2 \cdot 10^{-5}$ gauss follows. (auth)

41162 MAGNETIC FIELD IN INTERPLANETARY SPACE. Bhatia, V. B. (S. D. Coll., New Delhi). Z. Astrophys., 68: 400-5(1968).

A discussion of the interaction of the solar wind with the solar magnetic field is presented and the shape of the interplanetary magnetic field near the equatorial plane is derived. The lines of force are shown to be spirals. The angle that these spirals subtend at the radial direction is calculated. The results are consistent with the observations of the space probes. (auth)

41163 SPACED RECEIVER OBSERVATIONS OF PULSED RADIO SOURCES. Slee, O. B. (CSIRO, Sydney); Komesaroff, M. M.; McCulloch, P. M. Nature (London), 219: 342-3(July 27, 1968).

Simultaneous observations of pulsed radio sources by the 64-m Parkes radio telescope and the Culgoora radioheliograph, 325 km apart, show that most of the amplitude variations in the pulsed signals are imposed at or near the source itself. (auth) (UK)

41164 INTERSTELLAR MAGNETIC FIELD. Smith, F. G. (Univ. of Manchester, Eng.). Nature (London), 219: 355(July 27, 1968).

Roger and Shuter (Nature, 218: 1036 (1968)) suggested that

measurements by Smith (Nature, 218: 325 (1968)) of the interstellar magnetic field from the Faraday rotation of the plane polarized radio waves from the pulsar 0950 may be interpreted as a combination of ionospheric and interstellar rotation, and concluded that the upper limit of 2×10^{-7} gauss for the interstellar field should be replaced by a value of $\sim 10^{-6}$ gauss. It is stated in the present communication that such an interpretation is not justified, and revisions of the Roger and Shuter calculations are presented. The upper limit of the interstellar magnetic field remains at 2×10^{-7} gauss. (UK)

41165 CORRELATION BETWEEN SOLAR ACTIVITY AND THE BRIGHTNESS OF JUPITER'S GREAT RED SPOT. Smith, T. Scott (Goddard Space Flight Center, Greenbelt, Md.). Nature (London), 219: 357(July 27, 1968).

Reference is made to Graf et al., (Nature, 218: 857(1968)), and it is stated that the brightness of the Jovian spot appears to have two maxima for each single maximum of the Zurich sunspot number. A number of features of the solar cycle behave in a similar manner, particularly the incidence of proton flares. Since these flares are known to have very important terrestrial effects, it seems reasonable to suggest that the emission of solar particles may be more relevant to associate with Jupiter's spot than the uv radiation suggested by Graf et al. (UK)

41166 NATURE OF AN ULTRAVIOLET OBJECT IN SAGITTARIUS. Freeman, K. C. (Australian National Univ., Canberra); Rodgers, A. W.; Lynga, G. Nature (London), 219: 251-2(July 20, 1968).

A widened spectrogram of the intense uv object identified with the x-ray source GX 3+1 was obtained, using an image tube spectrograph. The magnitude and colors of this object are V = 13.4, B-V = +1.0, U-B = -0.9. A linear microphotometer record of the spectrum is shown. Many very broad emission bands were observed, arising from high excitation lines of HeII, OIII-VI, and CIII-IV. The measured wavelengths, identifications, widths and equivalent widths of these bands are tabulated. No Balmer lines were seen. The spectrum has some features in common with the central star of the planetary nebula NGC 5189, but is quite unlike that of Sco X-1. The galactic coordinates suggest that GX 3 + 1 is a galactic object. If this is so, it shows some of the broadest lines known in galactic emission line objects; the line widths are comparable only with those of some N-galaxies and supernovae. It seems that GX 3 + 1 is an extreme Wolf-Rayet star, or possibly a supernova. The identification of GX 3 + 1 with a WR star is consistent with the known galactic distribution of these stars. The electron temperature is estimated as $\sim 2 \times 10^6$°K. The distance to GX 3 + 1 is estimated from the optical reddening and from the observed x-ray flux as $\sim 5 \pm 2$ kpc. (UK)

41167 VRO 42 22 01: A VARIABLE SOURCE WITH CIRCULAR POLARISATION. Biraud, F.; Veron, P. (Observatoire de Paris, Meudon, France). Nature (London), 219: 254-5(July 20, 1968).

This radio source was recently identified with the variable stellar object BL Lac. Studies are reported indicating that the source is radio variable and probably circularly polarized, employing a 2,695 MHz receiver in conjunction with the Nançay radiotelescope. The source is reported to have a flux density of 4.0 flux units at 610.5 MHz (1 flux unit = 10^{-26} W/m^{-2} Hz^{-1}), and 7.3 flux units at 1,417 MHz. It does not appear in the 4c catalogue, hence its flux density at 178 MHz is less than 2.0 flux units. Its radio spectrum resembles that of the variable components of well-known radio sources. It appeared that the flux density varied strongly in September 1967 and April 1968. Variations of flux density in both vertical and horizontal polarizations are shown graphically. It also appeared that the source showed variable circular polarization just before strong increases in flux density. At its maximum magnitude the source would appear to be the brightest known quasar. It may be the first example of a radio source with significant circular polarization, and which is in addition variable with time. (UK)

41168 XUV AND SOFT X-RAY SPECTRA OF THE SUN. Jones, B. B.; Freeman, F. F.; Wilson, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nature (London), 219: 252-4(July 20, 1968).

Observations are reported from an attitude stabilized Skylark rocket launched from Woomera, S. Australia, on March 20th 1968. Included in the payload were two grazing incidence spectrographs, covering the wavelength ranges ~12 to 70 Å and ~140 to 500 Å. Both instruments had thin Al filters over the entrance slits to exclude the intense longer wavelength uv and visible radiation. X-ray and xuv pinhole camera photographs showed a belt of active regions extending across the north and south equatorial zones of the Sun. The spectrum recorded in the shorter wavelength range (soft x ray) is shown, and is in good agreement with the more prominent features recorded by previous investigators using scanning crystal spectrometers and photon counter detection. An interesting problem concerns the identity of the strong line at 22.09 Å, ascribed by other authors to Ca XIV $2p^3{}^4S^0 - 3d\ {}^4P$. The present observations indicate that this line can be resolved into two components at 22.09 and 22.03 Å, which are also two of the strongest of a group of lines which appear in the spectra of high temperature plasmas when oxygen is present. It is proposed that the solar lines are also due to oxygen, but their exact classification is not yet full established. The spectrum over the longer wavelength region (xuv spectrum) is also shown, with several identifications inserted. Photometric reduction of data is under way. The intensity ratio of O VII λ 21.60/λ 21.80 was measured as 1.9 ± 0.2, and can be used to determine the electron temperature of layers emitting the O VII lines. (UK)

41169 INFANT STARS. Reddish, V. C. (Royal Observatory, Edinburgh). Sci. J., 4: 30-5(July 1968).

The manner in which stars form is still not clear, although they appear to condense out of the vast diffuse clouds of gas which drift around the Universe. Various types of new-born stars are examined, such as dust embedded OB stars and Wolf-Rayet stars, T. Tauri stars and infrared stars, dark globules and H II globules. The subject is reviewed, but no definite conclusions are drawn. (UK)

41170 EVOLUTION OF THE UNIVERSE. Chiu, Hong-yee (Inst. for Space Studies, New York). Sci. J.; 4: 33-8(Aug. 1968).

The known laws of physics are now being proved to apply throughout time and space. This greatly decreases the number of cosmological models which could possibly explain how the Universe began and evolved. (auth) (UK)

41171 COSMOLOGY AND QUANTUM ELECTRODYNAMICS. Hoyle, F.; Narlikar, J. V. (Cambridge Univ., Eng.). Nature (London), 219: 340-1(July 27, 1968).

A fresh approach to quantum electrodynamics establishes a strong connection between local electrodynamics and cosmology, and seems to support the steady state model of the Universe. (auth) (UK)

41172 ROTATING NEUTRON STARS, PULSARS, AND SUPERNOVA REMNANTS. Pacini, F. (Cornell Univ., Ithaca, N. Y.). Nature (London), 219: 145-6(July 13, 1968).

Some problems connected with theories linking pulsars to the rotation of neutron stars are discussed. Since neutron stars can be formed during a supernova explosion, their rotation could also be coupled with the surrounding gaseous remnants, and the problem of the activity observed in the Crab Nebula and similar objects is also discussed. (auth)

41173 ANGULAR DIAMETER OF RADIO STARS. Harrington, M. C. (Air Force Office of Scientific Research, Washington, D. C.). Res. Rev. (Office Aerosp. Res.), 7: No 2, 15-17(Feb. 1968).

The use of magnetic tape recordings to facilitate a longer baseline for the measurement of the angular diameter of celestial radio sources with a radio interferometer is described. (TSS)

41174 NEWTONIAN ORBIT IN PULSATING UNIVERSE. Sengupta, P. (City Coll., Calcutta). Phys. Lett., 27A: 291 (July 15, 1968).

Newtonian orbit in pulsating Universe is obtained from the equation of geodesic. It is observed that the pulsating universe is the only nonstatic cosmological model (hitherto discovered) where the Newtonian orbit is obtained. (auth)

41175 CORRELATION OF CERTAIN TROPOSPHERIC AND IONOSPHERIC CONSTANTS WITH CHANGES IN THE VELOCITY OF THE SOLAR WIND. Smirnov, R. V. (Sea Hydrophysics Inst., Kiev). Dokl. Akad. Nauk SSSR, 180: 88-91(May 1, 1968). (In Russian).

Changes in the solar wind velocity and the polarity of the interplanetry field, measured by means of Vela, IMP-1, Mariner-1 and 2 satellites were compared with atmospheric changes near the Kurile-Kamchatka region, one of the presumed solar-controlled cycle generating centers; similar graphs were prepared for deviations of the critical f_0 frequencies of the F2 layer of the ionosphere. Examination of the shock wave front data indicated that the observed rapid changes are due to pressure changes of the solar plasma. Changes in the magnetosphere induce hydromagnetic and acoustical gravitational changes which increase the circulation in the upper atmosphere. The disruptive effects of the magnetohydrodynamic waves in the ionosphere cause temperature disturbances and change the effective recombination coefficients and rate constants of photochemical reactions. The fast transfer of perturbations from the upper atmosphere to the stratosphere and troposphere activates the Sun-controlled centers, changing the macrosynoptic pressures; thus changes in the velocity of the solar wind

are an important modulating force within the magnetosphere of the Earth. (TTT)

41176 EMPIRICAL DETERMINATION OF THE TEMPERATURES OF F DWARFS FROM Hβ PHOTOMETRY. Powell, A. L. T. (Royal Greenwich Observatory, Sussex, Eng.). Astrophys. Lett., 2: 11-15(Aug. 1, 1968).

Temperatures of eighteen F dwarfs were determined differentially with respect to the Sun by comparison of observed color indices and monochromatic magnitudes with model atmosphere predictions. A tight relationship was found to exist between Hβ indices and the derived temperatures, which follows closely a theoretical curve calculated from Hβ profiles. (auth)

41177 INTERGALACTIC H I ABSORPTION AT 21 CENTIMETERS. Penzias, A. A. (Bell Telephone Labs., Holmdel, N. J.); Scott III, Eugene H. Astrophys. J., 153: L7-9(July 1968).

The spectrum of Cygnus A was examined in a search for absorption features due to intergalactic H. This source was selected because it permits a sensitive test of the report by Koehler and Robinson (1966) of 21-cm absorption by general intergalactic HI with an optical depth of 2.4×10^{-3}, based upon their measurements of the spectrum of Forvax A. Observations were made with the 140-foot paraboloid of the NRAO and its recently completed broadband line radiometer with 40 channels 1 MHz wide spaced 1 MHz apart. (W.D.M.)

41178 POSSIBLE DETECTION OF A DENSE INTERGALACTIC PLASMA. Henry, R. C.; Fritz, G.; Meekins, J. F.; Friedman, H.; Byram, E. T. (Naval Research Lab., Washington, D. C.). Astrophys. J., 153: L11-18(July 1968).

Observations in the 1.5 to 8 keV range indicate that the isotropic x-ray background spectrum breaks at low energies, implying that a flux observed at 0.27 keV has an independent origin. This soft x-ray flux is attributed to free–free emission from a dense (10^{-3} to 10^{-6} particle cm^{-3}), hot ($3 - 8 \times 10^{5}$°K) intergalactic gas. A very soft x-ray source has been found. It is shown that the integral of such sources in other galaxies probably could not provide the observed high-latitude soft flux. (auth)

41179 OPTICAL POLARIZATION IN QUASI-STELLAR SOURCES. Visvanathan, N. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 153: L19-22(July 1968).

Fourteen quasars were observed for polarization at the Cassegrain focus of the 100-inch telescope. As the sky is found to be highly polarized, two sky observations were made at each angle. Seven of the fourteen quasars show measurable intrinsic polarization in the range from 0.014 to 0.087 mag. Within the error of the observation, those quasars which have been observed on different nights do not show variation in P and θ. (auth)

41180 SPECTROSCOPIC OBSERVATIONS OF SOME SUGGESTED QUASI-STELLAR SOURCES. Lynds, R. (Kitt Peak National Observatory, Tucson, Ariz.); Wills, D. Astrophys. J., 153: L23-7(July 1968).

Spectroscopic observations were obtained for identifications of twenty quasars. The evidence indicates that the objects are about equally divided between galactic stars and quarsars. Red shifts are given for seven extragalactic sources. (auth)

41181 THE 1966–1967 RADIO OUTBURST IN 3C 273. Dent, W. A. (Univ. of Michigan, Ann Arbor). Astrophys. J., 153: L29-32(July 1968).

At the time of the publication reporting the discovery of variable radio emission from 3C 273 (Dent 1965), the observed 8-GHz flux density had steadily increased by about 40% between mid-1962 and early 1965. In early 1966, the character of the variation changed suddenly with the observation of a very rapid increase in the cm wavelength flux densities of 3C 273. This radio outburst has been closely monitored with the Univ. of Mich. 85-foot antenna at 8.0 and 16.2 GHz. The results of these observations were combined with the earlier measurements made before the outburst and are presented. (W.D.M.)

41182 RADIO INTERFEROMETRY USING A BASE LINE OF 20 MILLION WAVELENGTHS. Clark, B. G. (National Radio Astronomy Observatory, Green Bank, W. Va.); Kellermann, K. I.; Bare, C. C.; Cohen, M. H.; Jauncey, D. L. Astrophys. J., 153: L67-8(July 1968).

Two radio telescopes located 3500 km apart were used as an interferometer at a wavelength of 18 cm, with a resolving power better than 0.005″. Six sources showed detectable fringes and contain one or more components smaller than 0.01″. (auth)

41183 DETECTION OF MICROWAVE RADIATION FROM THE $^2\Pi_{\frac{1}{2}}$, J = ½ STATE OF OH. Zuckerman, B.; Palmer, Patrick; Penfield, H.; Lilley, A. E. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 153: L69-76(July 1968).

The first detection of an excited state of interstellar OH has been made with the 140-foot telescope of the National Radio Astronomy Observatory. The F = 1 → 0 transition of the $^2\Pi_{\frac{1}{2}}$, J = ½ state at 4765 MHz has been detected in emission in the direction of the source of 18-cm anomalous emission in W3. The results of a search for this line in other sources are given, as well as the results of a search for the F = 1 → 1 transition. A discussion is given of several possible mechanisms for the emission and of their implications for future work in the microwave and infrared regions of the electromagnetic spectrum. (auth)

41184 RELATION BETWEEN QUASI-STELLAR RADIO SOURCES AND RADIO-COMPACT AND RADIO N GALAXIES. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 153: L33-7(July 1968).

It is shown that as far as present observational evidence goes the quasars are roughly continuous in their properties, with high-red shift radio galaxies which are compact or have compact parts. This class of objects appears to define a line in the red shift–apparent magnitude diagram which has a steeper slope than that required by a redshift–distance relation for objects all of the same luminosity. It does not appear possible to interpret this deviation with present information. (auth)

41185 PROPERTIES OF GALAXIES WITH PECULIAR NUCLEI. Sersic, J. L. (Univ. Nacional, Cordoba, Argentina); Pastoriza, M. Publ. Astron. Soc. Pac., 79: 152-5(Apr. 1967).

In a former note (Sérsic and Pastoriza 1965) the results of a survey of bright southern galaxies which were inspected for peculiarities in their nuclei were published. Although the sample was small (35) it suggested a relationship between the existence of a bar and the presence of abnormal features in their nuclei. The survey was extended to the whole sky by inspecting the Hubble plate collection at Pasadena. The discussion is restricted to galaxies brighter than 11.0 photographic total magnitude in order to include in the sample the objects previously found in the southern sky. (W.D.M.)

41186 SPECTRA OF PECULIAR NUCLEI IN GALAXIES. Pastoriza, M. G. (Instituto de Matematicas, Cordoba, Argentina). Observatory, 87: 225-8(Oct. 1967).

The spectra of the nuclear region of several galaxies mainly taken from a list of southern galaxies with peculiar nuclei published previously by Sérsic and Pastoriza (1965) are described. The spectra were taken with the fast spectrograph which presently is operating with the 60-inch telescope at Bosque Alegre (Cordoba). Dispersions of 480 Å/mm in the red and 240 Å/mm in the blue were used. Galaxies studied included NGC 1672, NGC 5236, NGC 7552, NGC 1808, and NGC 2997. (W.D.M.)

41187 OPTICAL SPECTRA NEAR 1 MICRON: THE SEYFERT GALAXY NGC 4151 AND THE PLANETARY NEBULA NGC 6543. Ford, W. K. Jr.; Purgathofer, A. T.; Rubin, V. C. (Carnegie Institution of Washington, D. C.). Astrophys. J., 153: L39-40 (July 1968).

An experimental image tube was used to obtain spectra of NGC 4151 and NGC 6543 at 193 Å mm^{-1}, centered near 9000 Å. Strong emission lines of [S III] λλ9069, 9532 are observed in NGC 4151. (auth)

41188 RADAR TESTS MAY VERIFY EINSTEIN THEORY. Aviat. Week Space Technol., 80: 70; 75(Apr. 8, 1968).

Empirical verification of the general theory of relativity on the basis of planetary radar experiments is discussed. Measured time delays for radar returns from the planet Mercury when their path is close to the Sun conformed within 20%, to delays predicted by Einstein's theory. The theory predicts that the velocity of electromagnetic radiation will be decreased by a strong gravitational field along the beam's path. The effect is small, but can be measured if the distances and the gravitational forces are sufficiently large. The time required for 2-way transmission between planets on opposite sides of the Sun and the strong gravitational field of the Sun's mass provide conditions for the experiment. The test is the fourth practicable one devised to validate the theory. The instrumentation involved in the test is described. The equipment was required to detect a delay of no more than 200 μsec in a round-trip transmission time of about 1600 sec, less than one part in 10 million. The experiment was conducted at 7840 Mc so that relativistic delay would account for more than 99% of the measured delay. At lower frequencies, the relativistic time delay would have been overshadowed by the time delay caused by interaction with electrons near the Sun. The accuracy of the initial radar test results was at least comparable to the accuracy achieved in measurements of the bending of light rays from distant stars by the gravitational field of the Sun. However the results are not considered sufficiently accurate to distinguish between predictions from general relativity and predictions from other non-Newtonian

theories. Other tests conducted to verify facets of Einstein's general theory are mentioned. (BBB)

41189 POLARIZATION AND SPECTRUM OF THE PRIMEVAL RADIATION IN AN ANISOTROPIC UNIVERSE. Rees, M. J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 153: L1-5(July 1968).

Repeated Thomson scatterings of the primeval radiation during the early phases of an anisotropic Universe would modify the black-body spectrum and produce linear polarization. Calculations are presented for a simple axisymmetric Universe, and results for more general cosmological models are summarized. These effects are potentially observable. (auth)

41190 DEVELOPMENT OF DAYTIME ASTROMETRY TO MEASURE THE GRAVITATIONAL DEFLECTION OF LIGHT. Zanoni, Carl Andrew. Princeton, N. J., Princeton Univ., 1967. 140p.

Thesis.

Previous attempts at measuring the relativistic deflection of star light in the Sun's gravitational field are analyzed. These attempts yield the relativistic light deflection to about 20% accuracy. Possible reasons limiting their accuracy are given. An alternative approach is presented which not only increases the time during which data can be taken but which is less susceptible to systematic errors. A new photoelectric telescope was specifically designed and is presently being assembled for daytime astrometry near the Sun. By using the diameter of the Sun as a unit of length, several of the sources of systematic errors present in previous attempts are overcome. Use of Schupmann medial telescope optics provides the means for overcoming the remaining sources of systematic error. This technique should yield the gravitational deflection of light to 1% accuracy. A prototype telescope was built and the results are given. Further applications of this technique and telescope to problems of relativity and astronomy are discussed. (Diss. Abstr.)

41191 CLASSIFICATION OF OH RADIO EMISSION SOURCES. Ball, John A.; Staelin, David H. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 153: L41-6(July 1968).

Those OH emission sources which emit most strongly at 1665 or 1667 MHz seem to be associated with H II regions, whereas those OH emission sources which emit most strongly at 1720 or 1612 MHz seem to be associated with combinations of non-thermal radio sources and H II regions. New observations at 1720 MHz are reported which indicate that the emission lines in those regions associated with non-thermal radio sources are less polarized. (auth)

41192 LOCAL GALACTIC MAGNETIC FIELD AND THE NATURE OF THE RADIO SPURS. Mathewson, D. S. (Australian National Univ., Canberra). Astrophys. J., 153: L47-53(July 1968).

Polarization measurements of 1400 stars at Siding Spring Observatory were combined with those of northern observers to provide conclusive evidence that there is a helical component of the local spiral-arm magnetic field. A model is produced. It is proposed that the well-known "spur" features of the galactic radio emission are the "radio tracers" of the helical structure defined by the model. (auth)

41193 PRODUCTION OF METASTABLE HELIUM BY ENERGETIC PARTICLES IN INTERSTELLAR GAS. Scherb, Frank (Univ. of Wisconsin, Madison). Astrophys. J., 153: L55-6(July 1968).

Energetic particles in interstellar space can produce helium in the metastable $2\,^3S$ state. The density of metastable helium in H I regions may be high enough to produce a detectable interstellar absorption line at 10830 Å. (auth)

41194 THE POSSIBILITY OF RESOLVING THE COMPONENTS OF SPICA THROUGH ITS LUNAR OCCULATIONS IN 1968. Herr, Richard B. (Univ. of Delaware, Newark). Astrophys. J., 153: L57-8(July 1968).

An appeal is made for photoelectric observers to record the diffraction patterns produced when Spica is occulted on August 27 and December 15. Observations combined from different sites would permit the angular separation of this eclipsing and spectroscopic binary to be measured, along with the relative luminosities of the components and, possibly, also their angular diameters. (auth)

41195 COMPARISON OF SOLAR X-RAY LINE EMISSION WITH MICROWAVE EMISSION DURING FLARES. Neupert, Werner M. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 153: L59-64(July 1968).

An analysis of x-ray emission at 1.87 Å observed during three solar flares by OSO-III indicates that maximum line emission is observed to occur 0.5 to 5 min after impulsive microwave maximum. The time integral of the centimetric radio burst corresponds best to the 1.87 Å line intensity during the rise to maximum x-ray intensity. The constancy of line emission from Fe IX through Fe XV, coupled with strong enhancements in higher ionization stages, suggests that additional material, not originally at coronal temperature, is rapidly heated and elevated to high stages of ionization during the event. Such heating and ionization may be the result of collisional losses by energetic electrons which are also responsible for the impulsive microwave burst. (auth)

41196 STARS IN CONTACT. Eggen, O. J. Sci. Amer., 218: No. 6, 34-40(June 1968).

The evolution and physics of contact binaries are discussed in detail and information which these systems can provide for general stellar evolution is considered. (W.D.M.)

41197 PROTON SYNCHROTRON EMISSION FROM COMPACT RADIO SOURCES. Rees, M. J. (Mount Wilson and Palomar Observatories, Pasadena, Calif.). Astrophys. Lett., 2: 1-4(Aug. 1, 1968).

Synchrotron emission constitutes an important drain on the energy of relativistic protons in compact radio sources, and protons may be responsible for most of the radio flux from quasi-stellar objects. Absorption is still governed by electrons, rather than protons, except below the electron gyrofrequency. The small low-frequency source in the Crab Nebula may be emitting proton synchrotron radiation. (auth)

41198 INTERPLANETARY SCINTILLATION OF THE OH EMISSION AT 1665 MHz FROM SAGITTARIUS B2. Robinson, B. J.; Goss, W. M. (CSIRO, Sydney). Astrophys. Lett., 2: 5-9(Aug. 1, 1968).

Scintillations of the OH emission at 1665 MHz from Sagittarius B2 were observed when the Sun passed 5° from the source in December 1967. The power spectra of the scintillations show that the OH emission at +67.4 and + 73.9 km/sec comes from regions with an angular size less than 0.1 arc sec. (auth)

41199 SOLAR SPIN-DOWN AND NEUTRINO FLUXES. Shaviv, G.; Beaudet, G. (Cornell Univ., Ithaca, N. Y.). Astrophys. Lett., 2: 17-19(Aug. 1, 1968).

A series of solar models with cores mixed to different extent was produced. All other parameters being equal, it is found that if the solar interior is assumed to be fully mixed the ^8B neutrino flux is reduced by at most a factor of 3.4 compared to the unmixed Sun. (auth)

41200 RELATIONSHIP BETWEEN SEYFERT GALAXIES, N-TYPE GALAXIES, AND QUASI-STELLAR OBJECTS. Barnothy, J. M.; Barnothy, M. F. (Univ. of Illinois, Chicago). Astrophys. Lett., 2: 21-6(Aug. 1, 1968).

It is suggested that Seyfert galaxies, N-type galaxies, and quasi-stellar objects have in common the source of light: the nucleus of a Seyfert galaxy, seen directly or amplified to differing degrees by a gravitational lens. While in quasi-stellar objects the lens is invisible, in N-type galaxies parts of it can be seen surrounding the the brilliant nucleus, which is in fact the image of the Seyfert galaxy behind it. (auth)

41201 RADIATION-DRIVEN WAVES AND THE SOLAR TEMPERATURE REVERSAL. Skalfuris, A. J. (City Coll. of New York). Astrophys. Lett., 2: 27-9(Aug. 1, 1968).

Recently it has been shown that a gas subjected to a fluctuating radiating boundary will respond aerodynamically with compression waves whose group velocities may run in value from zero to infinity (nonrelativistic) above the sonic limit (Vincenti and Baldwin 1962). Analysis of these waves in the solar atmosphere indicates a photospheric temperature reversal followed by a temperature discontinuity. (auth)

41202 INTERMEDIATE VELOCITY HYDROGEN CLOUDLETS IN THE GALAXY. Heiles, C. (Univ. of California, Berkeley). Astrophys. Lett., 2: 31-5(Aug. 1, 1968).

Nineteen more intermediate velocity cloudlets were found with the typical properties: radius, 5 pc; mass, 60 solar masses; density, 2 atoms/cm^3; kinetic temperature, less than 500°K. Some cloudlets are immersed in larger smooth backgrounds. One of the brightest cloudlets is connected to the local gas by a "bridge". Self-gravity is entirely negligible and the objects may result from a thermal or magnetic instability. (auth)

41203 RADIATION PRESSURE AND THE COMPOSITION OF THE SOLAR CORONA. Lambert, D. L. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. Lett., 2: 37-9(Aug. 1, 1968).

Cameron (1967) proposed that the overabundance of iron in the solar corona was due to an enhanced rate of ejection of iron atoms

from the underlying layers and that radiation pressure through line absorption was the responsible agent. The calculation of the radiation pressure is re-examined and it is shown that the effective force is considerably less than was estimated by Cameron. Furthermore, the observed abundances of Mg, Si, and Fe in the corona, chromosphere, and photosphere provide additional evidence that radiation pressure is not the mechanism producing the differences in the composition of the photosphere and corona. (auth)

41204 SPECTRAL CHARACTERISTICS OF RADIO SOURCES FROM A LIMITED SURVEY AT 6 CM. Blum, E. J. (Observatoire de Meudon, France); Davis, M. M. Astrophys. Lett., 2: 41-4(Aug. 1, 1968).

A search for new sources at 6-cm wavelength was made in an area totaling 96 square degrees. At least nine of the 27 sources found to be stronger than 0.1×10^{-26} Wm^{-2} Hz^{-1} have spectral indices more positive than −0.4. (auth)

41205 GRAVITATIONAL RADIATION DAMPING. Thorne, Kip S. (California Inst. of Tech., Pasadena. Univ. of Chicago). Phys. Rev. Lett., 21: 320-3(July 29, 1968).

An analysis is presented of the emission of gravitational waves by a star in nonradial pulsation. This analysis, rigorous to first order in the pulsation amplitude and to all orders in G and c, exhibits damping of the pulsation as the waves are emitted (gravitational radiation reaction). (auth)

41206 GRAVITATIONAL RADIATION FROM THE PULSARS. Weber, J. (Univ. of Maryland, College Park). Phys. Rev. Lett., 21: 395-6(Aug. 5, 1968).

Estimates are made of the expected gravitational radiation from the pulsars, assuming that they are either oscillating dwarf or neutron stars, or fast rotating binaries. It is concluded that a radiative Riemann tensor of magnitude $>10^{-42}$ cm^{-2} may be expected on Earth as a consequence of some of these assumptions. A large detector of the type already developed is likely to succeed in detecting a radiative Riemann tensor exceeding 10^{-42} cm^{-2} at pulsar frequencies. (auth)

41207 PREDICTIONS OF SEVERAL OH Λ DOUBLING TRANSITIONS SUITABLE FOR RADIO ASTRONOMY. Poynter, R. L. (California Inst. of Tech., Pasadena); Beaudet, R. A.: Phys. Rev. Lett., 21: 305-8(July 29, 1968).

New experimental results are reported which more precisely define the microwave spectrum of the OH free radical. More accurate line frequencies have been determined incidental to Stark-effect analysis of several transitions. Molecular parameters have been determined which are considerably more reliable than those which have been available in the literature. Because the lf limit of the spectrometer was 8.2 GHz, none of the Λ-doubling transitions below this frequency limit could be measured. However, enough higher frequency transitions have been observed that, if the $J = {}^3/_2$, $^2\Pi_{\frac{3}{2}}$ transition as observed by Radford is included, a fairly complete analysis of the microwave spectrum can be obtained. (W.D.M.)

41208 INFLUENCE OF X-RAY IRRADIATIONS ON THE CHARGE DISTRIBUTIONS IN METAL–OXIDE–SILICON STRUCTURES. pp 81-9 of Surface Properties of Oxidized Silicon, Kooi, E. New York, Springer-Verlag New York, Inc., 1967.

Insulated-gate silicon field-effect transistors were irradiated by x rays. The properties of the devices altered considerably depending on the total exposure to irradiation and the gate voltage as applied during the irradiation. The alterations can be explained by assuming that electric currents can flow in the MOS system under these conditions. This causes charge redistributions, which can be locked in at the moment that the irradiation is stopped. Due to these effects MOS devices may offer certain possibilities for detection of ionizing radiations. (auth)

41209 RELATIVE STRENGTHS OF RESONANCE LINES IN THE Ne I AND Ar I ISOELECTRONIC SEQUENCES. Murphy, P. W. (Univ. of Maryland, College Park). Astrophys. J., 153: 301-6(July 1968).

Relative line strengths for the resonance lines of ions in the Ne I isoelectronic sequence through Fe XVII and in the Ar I sequence through Fe IX were calculated. Intermediate coupling theory was used and the necessary parameters using observed energy levels were evaluated. The relative line strengths for the Ne I sequence agree well with previous calculations using Hartree–Fock wave functions. For Fe IX, whose resonance lines are observed in the solar ultraviolet spectrum, absolute line strengths, oscillator strengths, and transition probabilities using the scaled Thomas–Fermi potential to obtain the radial transition integral were calculated. The transition probabilities obtained are λ103.58, $A = 4.6 \times 10^{10}$ sec^{-1}; λ105.24, $A = 2.7 \times 10^{10}$ sec^{-1}. (auth)

41210 GROWTH RATE OF THE INTERSTELLAR GARDEN-HOSE INSTABILITY DUE TO COSMIC RAYS. Wentzel, Donat G. (Univ. of Maryland, College Park). Astrophys. J., 153: 331-3 (July 1968).

Parker (1965) showed that cosmic rays can inflate a loop of magnetic lines of force protruding from the galactic disk. If there are no other sources of cosmic-ray scattering, the cosmic rays finally cause disorder through the garden-hose instability. The present note is a derivation of the rate of this instability. (W.D.M.)

41211 MASS EJECTION FROM SUPERNOVA. Colgate, Stirling A. (New Mexico Inst. of Mining and Tech., Socorro). Astrophys. J., 153: 335-9(July 1968).

Recently, Arnett (1967) demonstrated that massive stars $\gtrsim 10M_\odot$ do not eject sufficient mass by the mechanism of neutrino heat transport to result in a major explosion of the star. This disagrees with the original formulation by Colgate and White (1966) (CW), and this note discusses the problem. The problem is important to cosmological considerations because the existence of relativistic gravitational collapse beyond the state of the classical neutron star depends upon the lack of major mass ejection by massive stars. Conversely, all stars undergoing nonrelativistic gravitational collapse according to the mechanism of CW may manage to eject sufficient mass so that the residual neutron star is stable. (W.D.M.)

41212 SUPERNOVA HYDRODYNAMICS. Arnett, W. David (Inst. for Space Studies, New York). Astrophys. J., 153: 341-8(July 1968).

Colgate (preceding note) criticized an investigation of gravitational collapse of nonrotating massive stars by the author (Arnett 1967) in which energy transport by electron-type neutrinos and antineutrinos was found to be much less efficient in massive stars ($M_{core} \gtrsim 8M_\odot$) than estimated by Colgate and White (1966). Mathematical models of these stars would not explode by this mechanism. The purpose of this note is to reply to Colgate's criticisms and point out some weaknesses in the analysis given by Colgate and White (1966). (W.D.M.)

41213 ON "SPACE-VELOCITY VECTORS FOR 3483 STARS" WITH ACCURATELY DETERMINED PROPER MOTIONS AND RADIAL VELOCITIES. Weller, W.; Crull, H. Jr.; Hynek, J. (National Radio Astronomy Observatory, Green Bank, W. Va. Northwestern Univ., Evanston, Ill.). Astrophys. J., 153: 349-51(July 1968).

A note of warning is issued to those who might try to use Bulletin No. 51 (Eggen 1962) in investigations of stellar motions. In seeking to use Bulletin No. 51 as a control for comparison with independently determined space vectors, the authors were disturbed at the discrepancies that were found between their results and those of Eggen. It was discovered that Eggen had used a gross approximation for the distance moduli of giant stars. A note in reply by Eggen is included. (W.D.M.)

41214 NARROW-BAND AND UBV PHOTOMETRY OF SCO X-1. Johnson, H. M.; Golson, J. C. (Lockheed Missiles and Space Co., Palo Alto, Calif. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 153: 307-12(July 1968).

Certain features of the x-ray source Sco X-1 were observed on various dates in 1967. The filter characteristics were derived from measures of the transmission curves made in 1967 with the Cary Recording Spectrophotometer at Kitt Peak. Most of the observing time was spent on Sco X-1, with interruptions for measures of an A0 comparison star, BD −15° 4301, and with measures of several standard stars at the beginning and end of each night. The narrow-band data were taken in pairs of 13-sec integrations per filter, or one two-filter observation per minute. (W.D.M.)

41215 PHOTOELECTRIC OBSERVATIONS OF FLARE STARS IN THE ULTRAVIOLET. MacConnell, Darrell J. (Univ. of Michigan, Ann Arbor. Cerro Tololo Inter-American Observatory, Arecibo, Puerto Rico). Astrophys. J., 153: 313-16(July 1968).

Ultraviolet monitoring of two flare stars shows that the frequency of activity is much greater than previously reported. Correlations between various parameters of the outbursts are discussed. (auth)

41216 STATISTICAL EQUILIBRIUM MODEL ATMOSPHERES FOR EARLY-TYPE STARS. IV. REMARKS ON OBSERVATIONAL TESTS. Mihalas, Dimitri (Univ. of Colorado, Boulder). Astrophys. J., 153: 317-20(July 1968).

A comparison is made between LTE and non-LTE models and observation following the approach of Strom and Kalkofen. It is found that near the main sequence the two sets of models are nearly indistinguishable but that large effects exist at lower gravities. The importance of very accurate values for the absolute-energy calibration of stars is emphasized. (auth)

41217 RADIATIVE TRANSFER IN DISPERSIVE MEDIA. Pomraning, G. C. (Gulf General Atomic, Inc., San Diego, Calif.). Astrophys. J., 153: 321-4(July 1968).

The equation of radiative transfer in a dispersive medium is derived from the equation of continuity for the photon distribution function. The properties of the medium are allowed to depend upon both position and time. (auth)

41218 THE SOLAR CORONAL TEMPERATURE: A REVISED VALUE USING NEW IONIZATION AND RECOMBINATION RATES. Kang, Ik-ju; Arny, Thomas T. (Southern Illinois Univ., Carbondale. Univ. of Massachusetts, Amherst). Astrophys. J., 153: 325-6(July 1968).

The determination of the solar coronal temperature from line ratios depends very strongly on many atomic parameters. This note reports some new calculations based on Shklovskii's method. It follows the work of Schwartz and Zirin (1959) but uses more accurately calculated values of the cross-section near threshold. Since most of the ionization will occur near threshold at the temperatures expected in the corona, the emission lines predicted differ greatly from those of Schwartz and Zirin. (W.D.M.)

41219 THE ROCKET ULTRAVIOLET SPECTRA OF A STARS. Maran, Stephen P. (Kitt Peak National Observatory, Tucson, Ariz.); Kurucz, Robert L.; Strom, K. M.; Strom, Stephen E. Astrophys. J., 153: 147-50(July 1968).

A synthetic spectrum covering the wavelength range 2000 to 3000 Å was computed for a temperature and surface gravity appropriate to a main-sequence early A star. The strongest lines and also those of potential value in discussing nucleosynthesis problems are tabulated. (auth)

41220 NEW SHORT-PERIOD BLUE VARIABLE. Landolt, Arlo U. (Louisiana State Univ. Observatory, Baton Rouge. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 153: 151-64(July 1968).

Photoelectric data which point to a 12.5^{m} variation in the brightness of a white-dwarf-like star are discussed. (auth)

41221 LIGHT VARIATIONS OF 73 DRACONIS. Stephien, Kazimierz (Univ. of California, Santa Cruz). Astrophys. J., 153: 165-8(July 1968).

Series of UBV photometric observations of 73 Draconis show the presence of a double wave in the visual light-curve that is not present in blue and ultraviolet. No appreciable changes in period, amplitude, and shape of light-curve have occurred during the last 16 years. The possibility of short-period variations with a period of several hours is indicated by a series of observations on one night. (auth)

41222 THE Ba II STAR HR 774. Cowley, Charles R. (Univ. of Chicago). Astrophys. J., 153: 169-75(July 1968).

Abundances are derived for the Ba II star HR 774 relative to the K2 II star π^6 Ori. The metal-to-iron ratios are very similar to those obtained by Warner. A possible underabundance of iron is discussed. (auth)

41223 THE MASS AND OTHER CHARACTERISTICS OF THE MAGNETIC STAR HD 98088. Abt, Helmut A. (Kitt Peak National Observatory, Tucson, Ariz.); Conti, Peter S.; Deutsch, Armin J.; Wallerstein, George. Astrophys. J., 153: 177-86(July 1968).

This system is a double-lined spectroscopic binary involving an Ap primary and having an orbital period of 5.905^{d}, which is also the period of the magnetic variation and rotation. The system is not an eclipsing one, but it is sufficiently inclined that the minimum mass of the Ap star is $M \sin^3 i = 1.70\ M_{\odot}$. The Ap star has hydrogen lines as in an A3 V star. From line ratios, it is concluded that the secondary is 1.2 mag fainter, or an A8 V star. Assuming a normal mass for the latter, an inclination of 67° and a primary mass of $2.2\ M_{\odot}$ are found. Such a mass is identical with that of a normal star at that location on the main sequence. This strongly suggests that the Ap star is on the main sequence for the first time. The spectrum variation is described and shows two maxima for some elements, with a phasing that is consistent with the characteristics of the eccentric orbit. The problem of synchronism between rotation and orbital motion for an eccentric orbit is discussed. (auth)

41224 SPECTRAL CLASSIFICATION AND SURFACE GRAVITIES FOR SOME BRIGHT ECLIPSING BINARIES. Olson, E. C. (Univ. of Illinois Observatory, Urbana). Astrophys. J., 153: 187-94(July 1968).

Line profiles of Hβ and Hγ were obtained for twenty eclipsing binaries with spectral types between O9 and A2. Surface gravities were determined by fitting these to theoretical profiles calculated by Strom and Peterson using the latest Griem broadening theory and a modification by Edmonds, Schiiter, and Wells. The spectral types required were found by spectrophotometry of selected lines. Comparison with gravities found from the binary solutions indicates that the latter broadening theory is the more nearly correct. (auth)

41225 SUBLUMINOUS LATE-TYPE STARS. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J., 153: 195-212(July 1968).

Photometric observations of 145 randomly selected proper-motion stars yield a minimum of 19 late-type white dwarfs on the assumption that space velocities greater than 600 km sec^{-1} do not occur among these objects. The possible sources of large ultraviolet excesses in late-type stars are also discussed. At least four new possible late-type white-dwarf members of the Hyades are isolated. (auth)

41226 THE SPECTRAL-ENERGY CURVES OF SUBDWARFS. II. Johnson, H. L. (Univ. of Arizona, Tucson. Univ. Nacional, Mexico City); Mitchell, R. I. Astrophys. J., 153: 213-19(July 1968).

Eight-color narrow-band photometric observations were made of approximately 120 subdwarfs, normal main-sequence dwarfs, and Hyades main-sequence stars. From these data, the changes in the stellar magnitudes as the metal lines are removed from Hyades-like stars, for the range of wavelength from 0.33 to 0.63 μ, were determined. For this wavelength region, the results are very similar to those obtained from UBVRIJHKL photometry, but the more numerous, narrower filters provide higher resolution. The removal of atmospheric metal lines from Hyades-like stars has little effect upon stellar colors for wavelengths longer than 0.45 μ; practically the entire excess in subdwarfs occurs at wavelengths shorter than 0.43 μ. (auth)

41227 FLUX MEASUREMENTS AT THE CENTERS OF STELLAR H- AND K-LINES. Wilson, O. C. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 153: 221-34(July 1968).

The coudé scanner of the 100-inch telescope was used as a two-channel photometer to measure the fluxes at the centers of stellar H and K lines, for the purpose of initiating a search for stellar analogues of the solar cycle. From the Strömgren–Perry catalogue 139 stars previously observed at 10 Å mm^{-1} dispersion were selected for this purpose and included most of those in which H–K emission had been seen on the spectrograms. Reasonable agreement between eye-estimated intensities and the photometric results shows that the procedure adopted is suitable for specifying chromospheric activity, but with an accuracy much improved over eye estimates. The probable error of a single measurement of a line is a little less than 2%. No undoubted variations were observed during a year's observation. However, the measures are discussed in connection with the Strömgren–Perry photometric parameters b–y, m_1, c_1. In this way it is possible to trace in some detail the course of chromospheric evolution as stars begin to move off the zero-age main sequence (ZAMS) toward the giant region. Doublet ratios of the chromospheric components of H and K are one of the by-products of the observations. They show that, in general, the optical thickness of the gas masses involved cannot be very great. (auth)

41228 DETERMINATION OF SOLAR ABUNDANCES BY A METHOD OF SPECTRUM SYNTHESIS. Ross, John; Aller, Lawrence (Univ. of California, Los Angeles). Astrophys. J., 153: 235-43(July 1968).

A procedure is described for obtaining the solar abundance, A, of an element, or more accurately gfA (where g is the statistical weight of the lower level and f is the oscillator strength). Instead of using the equivalent width of a line, one employs the entire profile. If the line falls in a crowded region of the spectrum where blending is severe, one attempts to reproduce the observed intensity distribution, $I_\lambda(0,\mu)$ over the relevant wavelength region by including all relevant bound–bound transitions. The calculation has been programmed for an IBM 360/75 computer. It was assumed that when the parameters of the lines contributing to this region are adjusted so that the computed $I_\lambda(0,\mu)$ distribution matches the observed $I_\lambda(0,\mu)$ distribution, the correct values of the parameter gfA have been obtained. The method is useful for those elements which are represented only by lines falling in crowded regions of the solar spectrum. The adjustable parameters are gfA and the damping constant, Γ. Depending on the basic physical data and the number of perturbing lines in the region, the value of gfA may be established to within 0.1 in the logarithm to the base 10. The damping constant, however, might be in error by a factor of 2. (auth)

41229 LINE FORMATION WITH NON-COHERENT SCATTERING BY ELECTRONS. I. PARAMETERIZED MODELS. Auer, L. H.; Mihalas, Dimitri (Joint Inst. for Lab. Astrophysics, Boulder, Colo. Univ. of Colorado, Boulder). Astrophys. J., 153: 245-56(July 1968).

The effects of the noncoherence of the radiation scattered by electrons upon the formation of spectral lines are examined. A flexible numerical approach, making use of the difference-equation

method of solving the transfer equation, is developed and applied to simplified models in which the lines are taken to be either in LTE or non-LTE, and allowance is made for electron scattering and continuous absorption. Radiation scattered by the atom is assumed to be completely redistributed, although the method is general enough to account for arbitrary redistribution functions. The present calculation differs from earlier work in that the electrons are assumed to be located in the same layers as the line and continuum opacity sources. Compared to the case of coherent electron scattering, measurable changes in the line profile occur if the electron-scattering coefficient outweighs continuum absorption. Emission lines are decreased slightly in intensity and develop extensive emission wings. Absorption lines are widened and deepened, and emission humps are obliterated. (auth)

41230 SCATTERING AND TRANSMISSION FUNCTIONS FOR NONCOHERENT SCATTERING. Sobouti, Yousef (Pahlavi Univ., Shiraz, Iran). Astrophys. J., 153: 257-66(July 1968).

Chandrasekhar's principles of invariance were used to solve the transfer equation of noncoherent scattering for the intensity of the diffusely reflected and transmitted radiation. (auth)

41231 THE GREAT SOLAR RADIO BURST OF MAY 23, 1967. Castelli, John P. (Air Force Cambridge Research Labs., Bedford, Mass.); Aaron, Jules; Michael, Glen A. Astrophys. J., 153: 267-73(July 1968).

On May 23, 1967, a solar radio burst was observed that was one of the largest ever recorded; it was associated with an Importance-2B flare. Using high-accuracy flux-density measurements at five frequencies ranging from 606 to 8800 MHz, its flux-density spectrum was compared with spectra of other flares observed in white light. It was found that along with most of the other white-light flares it displayed the U-type flux-density spectrum, i.e., high flux density in the meter and centimeter range and lower flux density in the decimeter range. The flare produced a PCA. (auth)

41232 MODEL FOR THE EARLY STAGE OF SOLAR RADIO BURSTS. Hagen, John P.; Barney, William M. (Pennsylvania State Univ., University Park). Astrophys. J., 153: 275-83(July 1968).

An analysis of detailed observations of the early stages of eight solar radio disturbances at 10700, 2700, 960, and 328 Mc is described. The data are consistent with a hot dense mass of plasma rising through the chromosphere. Four of the events show definite preburst expansion phases with radial velocities ranging between 1.28 and 43.8 km sec^{-1}. For the remaining events, the velocities at the time of the first outburst range between 15.0 and 152 km sec^{-1}. (auth)

41233 RECOMBINATION OF THE PRIMEVAL PLASMA. Peebles, P. J. E. (Princeton Univ., N. J.). Astrophys. J., 153: 1-11(July 1968).

A theory is presented for the plasma recombination that would have taken place when the Universe had expanded and cooled to a primeval fireball temperature of about 4000°K. The computed residual ionization of the hydrogen following this recombination is in the range of 2×10^{-5} to 2×10^{-4}, depending on the assumed cosmological model. In the closed cosmological model the matter temperature would have effectively decoupled from the radiation at a temperature of 1200°K, while in the lowest density model the matter temperature would not have fallen much below the radiation temperature before the galaxies formed. Also computed is the effect of the recombination radiation on the spectrum of the primeval fireball. (auth)

41234 SIGNIFICANCE OF THE FIRST BRIGHTEST GALAXIES IN RICH CLUSTERS. Peebles, P. J. E. (Princeton Univ., N. J.). Astrophys. J., 153: 13-18(July 1968).

It is shown that the observed distribution of luminosities of the bright galaxies in the great clusters is described by a model based on two assumptions, that there is a universal cluster luminosity function, not cut off at high luminosity, and that the masses of the rich clusters do not vary appreciably from one cluster to the next. (auth)

41235 LINE INTENSITIES IN QUASI-STELLAR OBJECTS. I. PHL 938, 3C 249.1, AND PKS 2251 + 11. Wampler, E. Joseph (Univ. of California, Santa Cruz). Astrophys. J., 153: 19-26 (July 1968).

Photoelectric scanner observations of PHL 938, 3C 249.1, and PKS 2251 + 11 are given. It is found that the Balmer decrement in 3C 249.1 and PKS 2251 + 11 is much steeper than predicted for radiative recombination. An upper limit to the $\lambda 4363/(\lambda 4959 + \lambda 5007)$ ratio in 3C 249.1 sets an upper limit to the electron temperature of 30,000°K in this object. (auth)

41236 A COMPARISON OF THE OPTICAL FORMS OF CERTAIN SEYFERT GALAXIES WITH THE N-TYPE RADIO GALAXIES. Morgan, W. W. (Univ. of Chicago). Astrophys. J., 153: 27-30(July 1968).

A comparison of the forms of seven Seyfert galaxies with N-type radio galaxies shows that the former do not make up a homogeneous group; some Seyfert galaxies would be classified as of class N, while others would not. A lack of homogeneity in the spectra of eight of the twelve original members of the Seyfert group is also found; some Seyfert galaxies have spectra closely resembling certain planetary nebulae, while others do not. The problem of finding new members of the group of Seyfert galaxies is complicated seriously by this inhomogeneity in the forms and spectra of the group. (auth)

41237 THE PECULIAR GALAXY NGC 7714. Demoulin, Marie-Helene; Burbidge, E. Margaret; Burbidge, G. R. (Univ. of California, San Diego). Astrophys. J., 153: 31-4(July 1968).

NGC 7714, one of the components of the system VV 51, has an emission-line spectrum indicating strong excitation, and velocity gradients in the excited gas which are probably due to rotation but may include non-circular motions also. [O I] λ6300, which has so far been detected only in Seyfert galaxies, is present in the center, and the emission-line strengths approach those in Seyfert nuclei, but the lines do not show the characteristic Seyfert broadening. The mass is small (a few $\times 10^9$ $M_\odot$) but cannot be precisely determined because of uncertainty in the orientation and the possible presence of non-circular motion. (auth)

41238 SURFACE PHOTOMETRY OF NGC 3115. Miller, R. H. (Univ. of Chicago); Prendergast, K. H. Astrophys. J., 153: 35-42(July 1968).

Data obtained photoelectrically and from isophotal tracings of photographs were combined into a single description with the results quoted as brightnesses along the photographic isophotes. NGC 3115 possesses a high degree of symmetry; all four quadrants are identical within the accuracy of the photometry. It gets noticeably bluer away from the center along the minor axis. Most of the measurements range from 20″ to 200″ from the center of the galaxy image. (auth)

41239 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. X. THE SMALL, HIGH-EXCITATION PLANETARY NEBULA IC 2165. Kaler, J. B. (Univ. of Illinois, Urbana); Czyzak, S. J.; Aller, L. H. Astrophys. J., 153: 43-8(July 1968).

Emission-line intensities were measured in IC 2165 between λλ3122 and 5007 Å to a minimum intensity of 7×10^{-4} I(Hβ) at peak instrumental sensitivity by a combination of photographic and photoelectric photometry. The nebula shows a wide range of excitation, from [Mg I] to [Ne V]. (auth)

41240 OBSERVATIONAL SPATIAL AND KINEMATIC MODELS OF PLANETARY NEBULAE. Weedman, Daniel W. (Univ. of Wisconsin, Madison). Astrophys. J., 153: 49-64 (July 1968).

Models are presented for a number of planetary nebulae representing both the physical distribution of emitting material and the kinematics of this material. The models are based on an analysis of the line profiles derived from high-dispersion spectrograms of bright emission lines in the planetaries. The planetary nebulae studied are NGC 7662, 7009, 6826, 6818, 6572, 6210, 3242, 2392, and IC 3568 and 418. The spatial models include descriptions of the shell shapes, thicknesses, and inhomogeneities. The kinematic features describe the expansion velocities of different parts of the shells. It is shown that ellipsoidal shells show a velocity of expansion which increases with distance from the central star, implying that the shell is now ellipsoidal because the original velocity of ejection varied with direction. The radii at different parts of a shell do not appear directly proportional to the expansion velocities, however, and this fact is used together with an apparent relation between a shell's thickness and its expansion velocity to infer that a long-term pressure acted to eject the shell. Evidence is also presented that some planetaries consist of at least two independently ejected shells, with the outer shell being more massive. (auth)

41241 THERMAL INSTABILITY IN IONIZED GASEOUS NEBULAE. Mathis, John S. (Univ. of Wisconsin, Madison). Astrophys. J., 153: 65-70(July 1968).

It is shown on very general grounds that the mechanism of thermal instability cannot be responsible for condensations in diffuse or planetary nebulae, at least unless most of the elements are in stages of ionization with potentials over 100 eV (these higher stages of ionization were not investigated in the present work). This statement can be made independently of the radiation field incident upon the gas and it is true for chemical compositions which vary rather widely from the commonly accepted as "normal." It does involve the neglect of Lyman-α radiation pressure in the gas. (auth)

41242 PLANE GALACTIC ORBITS IN A SPIRAL FIELD. **Barbanis, B. (Columbia Univ., New York. Univ. of Thessaloniki, Greece). Astrophys. J., 153: 71-81(July 1968).**

The deviations of a number of orbits of low-velocity stars due to the action of a typical spiral field are discussed. These deviations can be estimated to a good approximation by means of a linear epicyclic theory. (auth)

41243 RESONANT PERIODIC ORBITS. **Contopoulos, G. (Goddard Inst. for Space Studies, New York. Univ. of Thessaloniki, Greece). Astrophys. J., 153: 83-94(July 1968).**

Resonant periodic orbits, making n oscillations along the x-axis and m oscillations along the y axis, appear in a two-dimensional potential $V = \frac{1}{2}(Ax^2 + By^2)$ + higher-order terms whenever the ratio $A^{\frac{1}{2}}/B^{\frac{1}{2}}$ is near n/m. Such orbits can be found by means of a "third" integral in which small divisor terms have been eliminated. Orbits whose initial conditions are near those of a stable resonant periodic orbit are tube orbits. By finding the main periodic orbits, one can derive the main characteristics of the totality of orbits. An application in the case $A^{\frac{1}{2}}/B^{\frac{1}{2}} \simeq \frac{2}{3}$ is given. These considerations can be applied to find the main types of orbits in various galactic models. (auth)

41244 EARLY EVOLUTION OF A PROTOSTAR. **Ananaba, S. E. (Univ. of Nigeria, Nsukka); Gaustad, J. E. Astrophys. J., 153: 95-100(July 1968).**

The evolutionary track of a uniform density protostar of one solar mass in free-fall collapse is computed up to the point where the solid grains evaporate, at which point the luminosity is 3.4 $L_\odot$ and the surface temperature is 151°K. (auth)

41245 ON THE AGE AND INITIAL HELIUM ABUNDANCE OF EXTREME POPULATION II STARS. **Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge); Faulkner, John. Astrophys. J., 153: 101-12(July 1968).**

The following characteristics of metal-poor clusters were determined as a function of assigned cluster age and initial composition: M_{RG} = mass of a star along the giant branch, M_{core} = mass in the hydrogen-exhausted core of a star at the red-giant tip, and L_{to} = luminosity of a star near cluster turnoff. Using the observational fact that $\log L_{RR} \sim \log L_{to} + 1.4$, for every assumed initial composition and cluster age, the additional cluster characteristics: L_{RR} = luminosity of a cluster RR Lyrae star, M_{HB} = mass of a horizontal-branch star, and M_c = initial mass in the helium core of a star just reaching the horizontal branch were then determined. On further insisting that $M_c = M_{core}$, it was found that, for every choice of values for Z = heavy-element abundance and for Y = initial helium abundance, there corresponds a unique set of values for M_{RG}, M_{HB}, $\log L_{to}$, $\log L_{RR}$, and for cluster age t_c. Choosing $Z \sim 2 \times 10^{-4}$, as is consistent with spectroscopic results for extremely metal-poor clusters, it was found that cluster characteristics must lie within the following limits: $0.0 \leq Y \leq 0.33$, $20 \geq t_c \geq 9$, $0.46 \leq (M_{RG} - M_{HB}) \leq 0.0$, $0.71 \leq M_{HB} \leq 0.84$, $1.17 \geq M_{RG} \geq 0.84$, and $1.77 \leq \log L_{RR} \leq 1.99$, where t_c is in billions of years and M and L are in solar units. In each case, the left-hand limit follows from the requirement that $Y \geq 0.0$. The right-hand limit is a consequence of demanding that $M_{RG} \geq M_{HB}$. It is apparent that consistency is achieved with the results of recent "Big Bang" calculations ($Y \sim 0.3$) and with the simplest interpretation of the Hubble time ($t_c \leq \frac{2}{3}t_H \sim 9 \times 10^9$ yr) by supposing that horizontal-branch stars and red-giant stars (in any given cluster) are of essentially the same mass. It is felt that this consistency is not entirely fortuitous but, on the contrary, provides strong evidence for a high initial galactic helium abundance, formed during the early stages of a hot, expanding Universe described by the simplest of cosmologies. (auth)

41246 SOLAR MODELS AND NEUTRINO FLUXES. **Bahcall, John N.; Shaviv, Giora (California Inst. of Tech., Pasadena). Astrophys. J., 153: 113-25(July 1968).**

A set of accurate models were derived for the interior of the present Sun by varying within their accepted limits all the parameters, except the gravitational constant. Principal conclusions are: (1) the ^8B neutrino flux is $1.3\ (1 \pm 0.6) \times 10^7$ neutrinos cm^{-2} sec^{-1} at Earth's surface if the uncertainties are assumed to combine like statistical errors; (2) the primordial helium mass fraction probably lies in the range 0.24 to 0.28; (3) the primordial heavy-element mass fraction probably lies in the range 0.018 to 0.036; (4) the fraction of energy generated by the CNO cycle is 0.03 ± 0.02; and (5) the luminosity of the Sun has increased by about 35% in the last 4.7 billion years. Three numerical models for the solar interior are also presented and some of their principal characteristics are discussed. (auth)

41247 ASYMPTOTIC APPROXIMATIONS FOR STELLAR PULSATIONS. **Tassoul, Monique; Tassoul, Jean Louis (Princeton Univ. Observatory, N. J.). Astrophys. J., 153: 127-33(July 1968).**

This paper is concerned with the radial adiabatic pulsations of gaseous stars. A second-order asymptotic solution for the frequency spectrum is obtained on the basis of Olver's method. In the case of the two extreme models considered next, the relative error is less than 10^{-2} for the third mode of oscillation. (auth)

41248 EQUILIBRIUM STRUCTURE OF RAPIDLY ROTATING GASEOUS POLYTROPES AND COMPLETELY DEGENERATE SYSTEMS. **Anand, S. P. S. (Univ. of Toronto). Astrophys. J., 153: 135-45(July 1968).**

The equilibrium structures of axially symmetric, uniformly rotating gaseous masses in the polytropic and white-dwarf cases were determined. The effects of rotation to the second order in ω^2 (i.e., up to ω^4) were studied by Chandrasekhar's series-expansion method, where ω is the angular velocity of rotation. The mass, volume relation between central and mean densities, central pressure, and central temperature for rotating polytropes were obtained. β (ratio of gas pressure to total pressure due to gas and radiation) for distorted polytropes was also obtained. Similar structural parameters were also obtained in the case of a rotating white dwarf. Further, it is found that rotation increases Chandrasekhar's limiting mass for non-rotating white dwarfs by 3% at the maximum angular velocity consistent with equilibrium. The numerical values of various functions and structural parameters for rotating polytropes are given in tabular form. (auth)

41249 TEST FOR A POSSIBLE VARIATION OF NEWTON'S CONSTANT. **Finzi, Arrigo (Goddard Space Flight Center, New York). Icarus, 9: 191-6(July 1968).**

The assumption that Newton's constant G varies with the gravitational potential V according to the relation $G = G_0\ [1 + a(V - V_0/c^2)]$ has been considered by many authors; here a is a dimensionless constant of the order of unity. If one could land a spacecraft gently on Phobos, the analysis of the Doppler tracking data could yield the motion of the barycenter with an accuracy sufficient for a test of this relation. Alternatively, a test could perhaps be carried out with an Earth satellite. (auth)

41250 A POSSIBLE OBSERVATIONAL CORRELATION OF LUNAR LUMINESCENCE WITH THE K_p INDEX. **Foukal, Peter (Univ. of Manchester, Eng.). Icarus, 9: 162-74(July 1968).**

Simultaneous three-color photometry of the lunar craters Menelaus, Copernicus, Kepler, and Gassendi was carried out on seven nights between June 21 and July 1, 1967, to monitor possible short-period color changes on a time scale of less than 10 min. Abnormally strong brightness variations in the red and infrared bands, amounting to deviations as high as 10% from the mean value were recorded on the morning of July 28 at a phase angle of about 75%. Comparison with K_p values for these dates indicated a good, although not perfect, correlation between the amount of time variation in the red color index and the K_p value. It is tentatively concluded that if such observations can be continued it could be possible to prove the irrelevance of magnetospheric effects to the question of lunar luminescence. (auth)

41251 TRANSFER OF ENERGY IN SUNSPOTS. PART I. DISCUSSION OF THE MODELS WITH VERTICAL MAGNETIC FIELD. **Stankiewicz, A. (Astronomical Inst., Wroclaw). Acta Astron., 17: 341-52(1967).**

The models of sunspot with vertical magnetic field were considered. The results obtained show that at the present time the magnetohydrostatic methods do not give satisfactory sunspot models. To construct a more correct model of a sunspot, it is required to make use of the transfer methods. Then the magnetic pressure distribution is obtained as a self-consistent solution of the problem. (Meteorol. Geoastrophys. Abstr.)

41252 ROTATION AND ORIENTATION OF COSMIC DUST PARTICLES. **Dolginov, A. Z. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 179: 1070-3(Apr. 11, 1968). (In Russian).**

Light passing through the cosmic-dust "window" is polarized and its short wavelength portion is absorbed as a result of scattering on anisotropic nonspherical particles with specific spatial orientation. It is shown that the orientation of the dust particles is due to the corpuscular and light flux from the Sun. The particles are oriented not only in the interstellar but also in the interplanetary space and even in the atmosphere of the planets. Rotation of the dust particles is caused by the directional solar proton and photon fluxes. The conclusions apply also to dust particles near stars and to particles in the gas nebulae. The orienting action of fluxes ceases when the dust particles acquire their velocity; it is disturbed by the collision of randomly moving atoms with each other and the precession of the magnetic field. In the atmosphere of the Earth and of the planets, the wind also plays an important role in this respect. (TTT)

41253 MEASUREMENTS OF THE DENSITY OF THE SURFACE LAYER OF THE MOON BY MEANS OF THE AUTOMATIC

"LUNA-13" SPACE PROBE. Morozov, A. A.; Smorodinov, M. I.; Shvarev, V. V.; Cherkasov, I. I. Dokl. Akad. Nauk SSSR, 179: 1087-90(Apr. 11, 1968). (In Russian).

The density of the ground at the surface of the Moon was measured for the first time by a direct method on the basis of the intensity of the scattered γ radiation. The determination was based on the interaction of the γ quanta with the matter in the soil by the photoeffect, pair formation, and the Compton effect; the first two effects involve absorption of the quanta, the third one causes scattering. The γ quanta returning to the surface were counted by means of γ quanta protected by lead shield against the direct radiation from the γ source placed on the surface of the lunar soil. The density data indicated values of 0.8 and >2.1 g/cm^3. The first value indicates a foamy, light-slag like material, the second points to one like heavy concrete. On the basis of astronomical, photographic and radiophysical considerations, the first value appears to be correct. The measurements were based on a layer thickness of about 15 cm. (TTT)

41254 ASTRONOMICAL RESEARCH WITH THE LARGE SPACE TELESCOPE. Spitzer, Lyman Jr. (Princeton Univ., N. J.). Science, 161: 225-9(July 19, 1968).

Programs are outlined which represent some of the astronomical problems suggested for the 120-inch large space telescope (LST). The performance of the LST is briefly discussed. Galaxies and the Universe, interstellar gas, and the solar system are the areas covered in the possible applications of the LST. (W.D.M.)

41255 THE MAGNETIC AND RELATED STARS. II. Hack, Margherita (Astronomical Observatory, Trieste, Italy). Sky Telesc., 36: 92-9(Aug. 1968).

Some problems of chemical composition, atmospheric structure, and evolutional stage of magnetic stars are discussed. Proposed theories for magnetic stars are mentioned. (W.D.M.)

41256 RADIO PULSE PROFILES FROM PULSATING WHITE DWARFS. Bland, B. H. (Univ. of Manchester, Eng.). Nature (London), 219: 23-6(July 6, 1968).

Radii and relative rotation rates were deduced for the four known pulsating radio sources. Most of the emission appears to come from a wide belt near latitude 20° in each hemisphere, a distribution very similar to that of solar magnetic activity. Rotation rates increase and radii decrease with decreasing period. (auth) (UK)

41257 PROPER MOTION SEARCH FOR PULSARS. Argue, A. N.; Kenworthy, C. M. (Cambridge Univ., Eng.). Nature (London), 219: 45(July 6, 1968).

An attempt was made to identify the three pulsars CP 0950, 0834, and 1133 optically by proper motion surveys in the vicinity of the radio positions. Results were completely negative. Assuming this was because pulsars are fainter than the limit of detection, upper limits were set to their luminosity. Absolute magnitudes were derived; these placed the pulsars in the extreme dwarf range or beyond, in conformity with current ideas. It is concluded that if pulsars are not more than 100 pc distant they must either have remarkably low transverse velocities or their intrinsic luminosity at optical wavelengths must be very small. (UK)

41258 PERIHELION PRECESSION OF MERCURY. Bramanti, D. (Inst. of Physics, Florence). Nature (London), 219: 47-8 (July 6, 1968).

Since Einstein's theory predicts the correct advance of the perihelion of Mercury it is usually believed that the equivalence principle applies for large bodies such as the Sun, or the stars, for which no other experimental verification is at present known. It is shown that astronomical observations cannot exclude a failure of this principle for the Sun. The hypothesis that such failure may explain the small non-Newtonian effects observed in the solar system is also examined. The system Sun–Jupiter–Mercury is considered. (UK)

41259 PULSATION PERIODS OF ROTATING WHITE DWARFS. Durney, B. R. (High Altitude Observatory, Boulder, Colo.); Faulkner, J.; Gribbin, J. R.; Roxburgh, I. W. Nature (London), 219: 20-1(July 6, 1968).

When uniform rotation is included, the periods of pulsation for white dwarfs can become as small as 0.9 s. With nonuniform rotation, periods as short as 0.1 s may be possible. (auth) (UK)

41260 ACCURATE POSITIONS OF CP0950 AND CP1133. Mackay, C. D.; Elsmore, B.; Bailey, J. A. (Cambridge Univ., Eng.). Nature (London), 219: 21-3(July 6, 1968).

More accurate positions were found for the pulsed radio sources CP0950 and CP1133, using the Cambridge one-mile radio telescope. (auth) (UK)

41261 EFFECT OF FINITE BANDWIDTH ON OBSERVATIONS OF INTERPLANETARY SCINTILLATION. Little, L. T. (Cambridge Univ., Eng.). Planet. Space Sci., 16: 749-57(June 1968).

A theory is developed showing how the diffraction pattern produced by a random phase changing screen depends on the bandwidth of the incident radiation. The theory is applied to interplanetary scintillation, and it is found that at meter wavelengths the effect of receiver bandwidth will be an important limitation to scintillation observations made on radio sources within about 30° of the Sun. (auth) (UK)

41262 INTERPLANETARY NEUTRAL HYDROGEN AND THE RADIUS OF THE HELIOSPHERE. Hundhausen, A. J. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Planet. Space Sci., 16: 783-93(June 1968). (LA-DC-9282).

The supersonic flow of the solar wind is believed to terminate in a shock transition to subsonic flow somewhere in the outer part of the solar system. The radius of the roughly spherical region (the heliosphere) bounded by this standing shock wave has been estimated as ~20 AU as the result of a theoretical study by Patterson, Johnson, and Hanson (1963) of the distribution of interplanetary neutral hydrogen. The present paper describes a model of particle densities in the region beyond the heliosphere. It is shown on the basis of this model that most of the neutral hydrogen in the vicinity of the Earth does not originate near the shock boundary of the heliosphere, as assumed by Patterson, Johnson, and Hanson, but in a shell far beyond the shock. The neutral hydrogen density near the Earth can then be maintained only if the shock is near 5 AU. This reduced value for the radius of the heliosphere implies an interstellar magnetic field larger by an order of magnitude than that conventionally accepted. It is, however, in good agreement with recent estimates of the size of this region based on the solar modulation of galactic cosmic rays. (auth) (UK)

41263 ABSORPTION INTEGRAL FOR PLANETARY ATMOSPHERES. Plummer, W. T. (Univ. of Massachusetts, Amherst); Hauck, R. H. Planet. Space Sci., 16: 729-36(June 1968).

The Ladenburg–Reiche treatment of the curve-of-growth associated with a Lorentz absorption-line profile is applicable for the case of uniform pressure. In the case of an isothermal planetary atmosphere with an exponential pressure distribution an analogous treatment was made. The transition from linear to square-root types of absorption is more gradual than in the Ladenburg–Reiche case, and an error of more than 10% may be made in the transition region by representing a planetary atmosphere by a body of gas all at the mean pressure. A procedure is given for making the slant path correction for any point on the curve-of-growth, and at any planetary phase angle. (auth) (UK)

41264 LATITUDE-INTENSITY STRUCTURE AND PITCH-ANGLE DISTRIBUTIONS OF LOW-ENERGY SOLAR COSMIC RAYS AT LOW ALTITUDE. Blake, J. B.; Paulikas, G. A.; Freden, S. C. (Aerospace Corp., Los Angeles, Calif.). J. Geophys. Res., 73: 4827-34(Aug. 1, 1968).

Solar protons (1.1 to 1.6 MeV) and alpha particles (4.1 to 15 MeV) were observed over the polar caps associated with the proton event of August 28, 1966. Persistent latitudinal structure in the proton flux was observed. Ordering of the structure by magnetic latitude over both polar caps during a given orbit shows that it is a spatial effect associated with nonuniform access of solar protons to high latitudes. Examples of the latitudinal structure are shown. Pitch-angle distributions were observed that clearly delineated a region of quasi-trapping; the changes in the pitch-angle distributions during a representative pass as the spacecraft 1966-70A traversed the region of quasi-trapping are shown. No evidence for the durable containment of the quasi-trapped solar alpha particles was observed. (auth)

41265 SOLAR NEUTRON TRANSPORT IN THE EARTH'S ATMOSPHERE. Alsmiller, R. G. Jr.; Boughner, R. T. (Oak Ridge National Lab., Tenn.). J. Geophys. Res., 73: 4835-42 (Aug. 1, 1968).

The neutron flux per unit energy induced in the Earth's atmosphere by solar neutrons was calculated as a function of atmospheric depth for depths of less than 300 g/cm^2 (~30,000 ft). The calculated flux is compared with estimates of the cosmic-ray neutron flux per unit energy, and it is found that for many flares the solar neutron flux per unit energy is sufficiently above the cosmic-ray neutron flux per unit energy to produce a measurable effect at both balloon and aircraft altitudes. (auth)

41266 SOLAR WIND ELECTRONS: VELA 4 MEASUREMENTS. Montgomery, Michael D.; Bame, S. J.; Hundhausen, A. J. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 73: 4999-5003(Aug. 1, 1968).

Since 1966 a number of measurements of electron fluxes in

interplanetary space have been reported. Some of the results have varied widely. This letter presents Vela results that give a consistent and meaningful description of the electron component of the solar wind plasma. The electron characteristics are compared with nearly simultaneously measured proton characteristics. This comparison yields a more complete description of the plasma and provides a check on the results. (W.D.M.)

41267 ENERGY DEPOSITION IN THE SOLAR WIND BY FLARE-GENERATED SHOCK WAVES. Dryer, Murray; Jones, Donald L. (Environmental Science Service Administration, Boulder, Colo.). J. Geophys. Res., 73: 4875-81(Aug. 1, 1968).

Similarity theory is used together with satellite data to estimate limits on the energy released by three solar flares. Bounds on the energy thereby distributed to the solar wind by satellite-observed shock waves are 10^{30} to 10^{32} ergs for each of the flares. The blast-like origin of these flares appears to be confirmed. (auth)

41268 RADIO PROPAGATION MEASUREMENTS OF PULSED PLASMA STREAMS FROM THE SUN USING PIONEER SPACECRAFT. Koehler, Richard L. (Stanford Univ., Calif.). J. Geophys. Res., 73: 4883-94(Aug. 1, 1968).

Radio signals at 50 and 425 MHz are sent from Stanford to spacecraft in deep space to determine the electron number density, structure, and behavior of the interplanetary medium. Total electron contents of up to 200×10^{16} el/m^2 have been measured, a substantial portion of which were located in the dense ionosphere surrounding the Earth. The ionospheric portion was subtracted to obtain the interplanetary content. Three sudden, large increases in the electron content were observed: October 24, 1966; November 10, 1966; and January 25, 1967. The sudden changes in content ranged from 30 to 120×10^{16} el/m^2 (electrons/meter^2) over propagation paths of 12 to 55 Gm and occurred in a region within 20 Gm of the Earth's orbit (1 Gm = 10^9 m = 10^6 km). They are explained by a model with a rectangular-shaped increase in electron number density with a spherical wavefront traveling radially from the Sun at 300 to 400 km/sec. The increase in density ranged from 30 to 55×10^6 el/m^3 above the background density, extending over a region from 5 to 10 Gm along a solar radial. (auth)

41269 RADIO SOURCES OPPOSITE QUASARS AS A COSMOLOGICAL TEST. Solheim, J. E. (Univ. of Texas, Austin). Nature (London), 219: 45-7(July 6, 1968).

Reference is made to the possibility of a closed Universe model with the pole at a redshift $z = \simeq 1.7$. A possible observation in such a Universe would be images in opposite or near opposite directions to the original object, if the latter is not too far from the pole. This may happen for a few 4C radio sources. A further possible observation is radio sources opposite known quasars, and such a possibility is discussed. A cosmological model is considered with a pole at red shift 1.7, deceleration parameter $q_0 = -1.4$, and density parameter $\sigma_0 = 0.085$. In this model objects must have lifetimes of the order of 1 to 10×10^9 yr to be seen in two directions, because of the difference in light travel time. This is too long for a quasar, but it may be possible to observe the object in a pre-quasar or post-quasar stage as a radio source or even as a faint optical object. A comparison of the optical positions of 103 quasars with radio sources in opposite directions was made. Compared with expectations from a random distribution, an excess of opposite pairs with separation in the range 25′ to 55′ was found, the main component of the excess being between 25′ and 35′. The excess of opposite pairs was also concentrated in the red-shift range 1.2 to 2.0. If double images of quasars are found for objects with redshift 1.2 to 2.0 only, this may be interpreted as a result of the radio source existing in a pre-quasar stage for up to 12×10^9 yr and a post-quasar stage of maximum duration 7×10^9 yr. The distribution of separation versus redshift was also studied. Separation of images may be caused by the space velocity of the object. An interesting case is that opposite the quasar 0952 + 18 a possible quasar identification 2154−18, with unknown redshift and magnitude, was found. A further interesting configuration was the field opposite 3C 454; within 1° from the position, opposite this quasar, two radio sources were found, the line between these passing through the anti-quasar position. (UK)

41270 EFFECT OF MASS ON FREQUENCY. Sadeh, Dror; Knowles, Stephen; Au, Benjamin (Naval Research Lab., Washington, D. C.). Science, 161: 567-9(Aug. 9, 1968).

Two experiments are described where an apparent decrease in frequency was detected when the optical path was in the vicinity of a mass. In the first experiment the 21-centimeter absorption line from Taurus A was observed near occulation by the Sun. In the second experiment the frequency of a portable cesium clock was compared with the frequency of a similar clock which transmits its signals from Cape Fear, North Carolina. A decrease of frequency of the received signals as a function of the distance between the two clocks was apparent. Several relevant observations (the redshift of lines from the Sun, the Mössbauer determination of the gravitational redshift, and the cosmological redshift are discussed in view of the present results. (auth)

41271 X-RAY STRUCTURES OF THE SUN DURING THE IMPORTANCE 1N FLARE OF JUNE 8, 1968. Vaiana, G. S.; Reidy, W. P.; Zehnpfennig, T.; VanSpeybroeck, L.; Giacconi, R. (American Science and Engineering, Cambridge, Mass.). Science, 161: 564-7(Aug. 9, 1968).

High-resolution solar x-ray images were obtained with a rocket-borne grazing incidence telescope. The x-ray flare is large in extent, has fine structure, and follows a neutral magnetic line. X-ray emitting coronal links interconnect active regions. The general coronal emission at the limb and several faint regions on the disc are observed. (auth)

41272 ENERGY PRODUCTION IN STARS. Bethe, Hans A. Science, 161: 541-7(Aug. 9, 1968).

The early speculations on energy production in the Sun are discussed briefly. Topics covered include properties of stars, thermonuclear reactions, nuclear reactions in main-sequence stars, experimental results, completion of the proton−proton chain, evolution of a star, and buildup and dispersal of elements. (W.D.M.)

41273 PULSED RADIO SOURCES. Robinson, B. J. (CSIRO, Sydney). Aust. Phys., 5: 83-5(June 1968).

A short summary is given on the known characteristics of pulsars. Tentative models are outlined. (W.D.M.)

41274 COSMIC-RAY-PRODUCED ^{3}H AND ^{3}He IN STONY METEORITES. Kruger, S. T.; Heymann, D. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 4784-7(July 15, 1968).

The estimation of the ratio of ^{3}H production to ^{3}He production (ϵ) by radioinduced spallation in oxygen from certain systematics in the data of Goebel et al. (1964) is considered. A plot of ^{3}H/^{3}He versus the ratio of neutrons to protons in various elements suggests a value of approximately 0.5. This value of ϵ for oxygen is then used to calculate ϵ for various classes of stony meteorites. (A.G.W.)

41275 PLANETARY MODEL FOR RAPIDLY PULSATING RADIO SOURCES. Aldridge, F. T. (Univ. of California, Los Angeles). Proc. Nat. Acad. Sci. U. S., 60: 743-6(July 1968).

The binary star theory of the pulsar mechanism is modified by concentrating all the mass in one star and making the other body a small planet. The star must be very dense in order to provide the short orbital radius needed. For a star of solar mass, the shortest observed period of 0.25 sec will require a planetary orbital radius of 6×10^7 cm, and therefore a minimum stellar density of 5×10^{10} gm/cc. If the star has a magnetic field capable of forming a Van Allen type of radiation belt at the planetary distance, all the observed properties of the pulses can be explained by a mechanism similar to that proposed by Marshall and Libby (1967) to explain the influence of I_0 on the decameter radiation from Jupiter. (W.D.M.)

41276 STATISTICAL ANALYSIS OF LARGE-SCALE BRIGHTNESS AND VELOCITY FLUCTUATIONS IN THE SOLAR ATMOSPHERE. Appenzeller, I.; Schroeter, E. H. (Univ., Goettingen, Ger.). Solar Phys., 4: 131-41(June 1968).

Simultaneous photoelectric recordings of the intensities and the Doppler shifts in 5 Fraunhofer lines (Hβ, NaD$_1$, Mgb$_2$, Feλ5123, Feλ5223) were used to study the structure of local large-scale fluctuations of the intensity and velocity in different layers of the solar atmosphere. Autocorrelation and cross-correlation functions and the power spectra of the fluctuations were derived. Fluctuation patterns with a characteristic size of 3 to 4×10^4 km were found in all observed lines. The intensity of the fluctuations decreases sharply from the chromospheric Hβ core to the weak iron lines. The results are discussed in terms of the solar supergranulation pattern. (auth)

41277 INTENSITY, VELOCITY, AND MAGNETIC STRUCTURE OF A SUNSPOT REGION. I. OBSERVATIONAL TECHNIQUE; PROPERTIES OF MAGNETIC KNOTS. Beckers, J. M. (Sacramento Peak Observatory, Sunspot, N. Mex.); Schroeter, E. H. Solar Phys., 4: 142-64(June 1968).

The observational setup for a detailed study of the velocity, intensity and magnetic-field fine structure in and around a sunspot is described. On highly resolved spectra a large number of points with strong magnetic fields (magnetic knots) was detected in the vicinity of a sunspot. The magnetic field in these knots causes a striking decrease of the line depth (or a "line gap" after Sheeley, 1967). The properties of the magnetic knots are: (1) magnetic fields up to 1400 gauss; (2) diameter ≈1100 km; (3) coincidence with dark intergranular spaces; (4) generally downward material motion; (5) lifetime >30 min; (6) estimated total number around an unipolar spot ≥2000; (7) combined magnetic

flux comparable to the sunspot flux; (8) coincidence with Ca^+ plages. For the smallest sunspots (pores) magnetic fields >1500 gauss were obtained. Hence a magnetic field of about 1400 to 1500 gauss appears to be a rather critical level for pore and spot formation. A large number of small areas producing line gaps without measurable magnetic field were found. These nonmagnetic gap regions' coincide with bright continuum structures. Some aspects arising from the occurrence of hundreds of magnetic knots in an active region are discussed in the last section. (auth)

41278 ON THE RELATION BETWEEN THE PHOTOSPHERIC INTENSITY, VELOCITY, AND MAGNETIC FIELDS. Beckers, J. M. (Sacramento Peak Observatory, Sunspot, N. Mex.); Schroeter, E. H. Solar Phys., 4: 165-7(June 1968).

Spectra of the quiescent photosphere in the Fe line 26173 Å (g = .25) were obtained simultaneously in the two opposite circular polarizations. Two sets of spectra were selected to measure and to correlate the continuum intensity, the Doppler shift, and the magnetic field of small details of the sun. (TSS)

41279 EVERSHED MOTION IN SUNSPOTS. Chitre, S. M. (California Inst. of Tech., Pasadena). Solar Phys., 4: 168-75 (June 1968).

The Evershed motion is postulated as a steady, laminar flow of material along a limiting field line which separates the umbral magnetic field from the penumbral. Assuming that the Evershed flow starts from the spot base with a velocity which is adequate to carry the convective flux at that level, the velocity at the surface comes out to be of the order of 1 km/sec, in good agreement with the observed Evershed velocity. (auth)

41280 EMISSION CORES IN H AND K LINES. IV. CENTER-TO-LIMB VARIATION. Athay, R. Grant; Skumanich, A. (High Altitude Observatory, Boulder, Colo.). Solar Phys., 4: 176-84 (June 1968).

Calculations are made for the center-limb variations of the K_2 and K_3 components of the solar CaII K line using an optically thick model of the chromosphere. The center-limb variations are shown to require an increase of Doppler width with height in the chromosphere and to depend critically upon the location of the point where $\Delta\lambda_D$ has increased by a factor e. Good agreement with observations is found when, and only when, the increase in $\Delta\lambda_D$ occurs nearly simultaneously with the increase in chromospheric temperature. (auth)

41281 HIGH-RESOLUTION PHOTOGRAPHY OF THE SOLAR CHROMOSPHERE. I. THE 30-cm REFRACTOR OF THE C.S.I.R.O. SOLAR OBSERVATORY. Loughhead, R. E.; Bray, R. J.; Tappere, E. J.; Winter, J. G. (CSIRO, Sydney). Solar Phys., 4: 185-95(June 1968).

A new telescope designed for high-resolution photography of the chromosphere is described. It is mounted in the open air on a 15-m tower and is provided with air suction shields to cool all surfaces exposed to the Sun's rays. The best moments for photography are selected by a seeing monitor. The highest resolution so far attained in 0".75 of arc, compared with a theoretical resolution limit at Hα of 0".55. (auth)

41282 OBSERVATIONS OF SOLAR CHROMOSPHERIC FINE STRUCTURES IN THE LIGHT OF LYMAN-α. Sloan, William A. (Yale Univ., New Haven. Naval Research Lab., Washington, D. C.). Solar Phys., 4: 196-211(June 1968).

A Cassegrain telescope with a resolution of 2 sec of arc was successfully flown in an Aerobee-150 rocket from White Sands Missile Range on October 20, 1965. A pinhole, 33 μ in diameter, was placed at the focus of the telescope, followed by a photoionization detector with a lithium fluoride window. The instrument was kept pointed at the sun by a biaxial solar pointing control. Results indicate that in Lyman-α the solar surface shows structures whose characteristic dimensions can be as small as 2 sec of arc, which corresponds to the limit of instrumental resolution. Larger structures with very sharp gradients were also found. Intensity ratios between bright and dark areas are typically a factor of 1.7. Isophote maps of two small selected areas are discussed in this paper. The results were obtained in an undisturbed (free of plages) portion of the solar disk. (auth)

41283 MAGNETIC FIELDS AND THE TEMPERATURE STRUCTURE OF THE CHROMOSPHERE-CORONA INTERFACE. Kopp, Roger A.; Kuperus, Max (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys., 4: 212-23(June 1968).

The temperature structure of the transition region between the chromosphere and corona is discussed in the context of current ideas about magnetic fields in these layers. Magnetic channeling of the downward conductive heat flow from the corona into the regions of enhanced field at the supergranulation boundaries is proposed as a mechanism for explaining the measured intensities of solar untraviolet emission lines which originate in layers with temperatures below $10^{5.6}$K. It is shown that nearly all of the observed ultraviolet line emission originates in interspicule regions, and that this emission plays an important part in the energy balance of the cooler layers of the transition region. It is suggested that certain motions observed in the upper chromosphere may represent the earliest visual evidence for conversion of inflowing conduction energy into kinetic motions. (auth)

41284 PHOTOELECTRIC MEASUREMENTS OF THE GREEN CORONAL LINE DURING THE ECLIPSE OF NOVEMBER 12, 1966. Malville, J. McKim; Schmahl, Edward J. (High Altitude Observatory, Boulder, Colo.). Solar Phys., 4: 224-8(June 1968).

A line-to-continuum ratio of the green line equal to 2.1 Å was measured above the West limb at the height p = 1.75 solar radii during the eclipse. The lower limit to the abundance of iron relative to hydrogen obtained from these measurements is 4×10^{-5}. (auth)

41285 PROTON FLARE OF AUGUST 28, 1966. Dodson, Helen W.; Hedeman, E. Ruth (Univ. of Michigan, Ann Arbor). Solar Phys., 4: 229-39(June 1968).

The proton flare of August 28, 1966 began on Hα records at $15^h21^m35^s$ UT. It presented an unusually complex development with flare emission occurring in two distinct plages. The brightest part of the flare attained maximum intensity, 152% of the continuum, between 15^h30^m and 15^h32^m UT. Photometric measurements show that a long-enduring part of the flare continued to decline in intensity until at least 21^h20^m UT. The flare developed first in parts of the plages that were near the extremities of a filament and a complex system of curvilinear absorption structures, possibly in eruptive prominence in projection. During the rise to maximum intensity a large expanding feature moved southward from the site of the flare with a velocity ~700 km/sec. Its appearance on monochromatic records of the chromosphere made in the center of Hα and 0.5 Å on either side was consistent with the effect of an advancing phenomenon that induces a small shift of the Hα absorption line, first to longer, and then to shorter wavelengths. Two bright flare-filaments were obvious aspects of the event by 15^h28^m and dominated the main phase of the flare. Loop-type prominences were observed in absorption as early as 15^h40^m. (auth)

41286 . SINGULAR VARIATIONS NEAR THE CONTACT DISCONTINUITY IN THE THEORY OF INTERPLANETARY BLAST WAVES. Lee, T. S. (Univ. of Minnesota, Minneapolis. Naval Research Lab., Washington, D. C.); Balwanz, W. W. Solar Phys., 4: 240-58(June 1968).

Attention is called to a feature of the ideal interplanetary blastwave according to the Parker type of formal theory which has not been scrutinized in the literature before. It is shown analytically that, on account of inertial effects, a gradient singularity of the radial momentum transfer rate arises in association with the local coronal accumulation in front of the rear propelling contact surface postulated in the theory and that such a local accumulation is a general result for power-law explosive waves extruding against an ambient hydrogen solar wind having a strictly inverse-square radial decay in density. The usual numerical schemes are rendered ineffective for the determination of the expected singular local-wave behavior. To circumvent the difficulty, a combined numerical-integral technique has been developed and in this work it was applied on six specific model waves, including both the decelerating and the non-decelerating, which have energies increasing with time as t^K with K = 28, 4, 1, ½, ¼, and ⅛, respectively. Also, a local solution corresponding to the limiting approximation of a constant material velocity gradient was analytically constructed. The importance of the local singular behavior is quantitatively appraised and certain interplanetary implications are given cursory inferences. It is considered that the new results should have inescapable relevance with regard to (1) the quantitative determination of the progressive peak transverse magnetic field during an interplanetary storm and (2) the theoretical determination of the macroscopic stability of the postulated contact surface. (auth)

Atomic and Molecular Physics

Refer also to abstracts 41209, 41270, 41564, and 41585.

41287 (INP-608) MOLECULAR DYNAMICS IN GASEOUS AND SOLID METHANE STUDIED BY THE INELASTIC NEUTRON SCATTERING METHOD. Bajorek, A.; Natkaniec, I.; Parlinski, K.; Sudnik-Hrynkiewicz, M.; Janik, J. A.; Janik, J. M.; Otnes, K.; Tunkelo, E. (Institute of Nuclear Physics, Krakow (Poland)). 1968. 26p. Dep.

Measurements of the neutron scattering double differential

cross section for gaseous methane (scattering angles 30 and 130°) and for solid methane (scattering angle 30°) were performed. The results for gaseous methane were compared with the Rahman–Griffing theory. A deviation from this theory was found for the 30° scattering angle. After estimation of the possible effect of multiple scattering, this deviation was interpreted as being caused by molecular interactions in gaseous CH_4. The results for solid methane were compared with the theory in which free molecular rotations were assumed, whereas the translations were replaced by a Debye vibrational spectrum corresponding to the Debye temperature 48°K. In the experimental data no distinct discrete rotational peaks were observed at a measurement temperature of 80°K. This lack of rotational peaks indicates some rotational hindrance (but by no means leading to a torsional oscillation). A rather good agreement of both theoretical and experimental scattered intensities at small energy transfers favors the choice of the translational model assumed. (auth)

41288 (JINR–P4-3842) WKB METHOD OF SOLVING THE PROBLEM OF CONFIGURATIONAL INTERACTION OF TERMS IN THE ZeZ′ SYSTEM. Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 20p. (In Russian). Dep.

The phenomenon of the pseudointersection of the terms in the ZeZ′ system, which was observed recently, is discussed. By means of the WKB method the formulas were obtained for the value of splitting the δE levels at the point of pseudointersection, as well as the R_0 distances between the charges Z and Z′, at which these pseudointersections appear, the E_0 energy values in the point of pseudointersection and the function determining the total number of such pseudointersections in the system ZeZ′ at given values of charges Z and Z′ and quantum numbers n and n′ of interacting terms. The formulas obtained are compared with the numerical calculations. (auth)

41289 (JINR–P4-3860) MESIC ATOM PROCESSES AND LARGE MESIC MOLECULES MODEL. Gershtein, S. S.; Petrukhin, V. I.; Ponomarev, L. I.; Prokoshkin, Yu. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 64p. (In Russian). Dep.

Recent experimental and theoretical papers in which the processes of the meson absorption in chemical compounds was investigated are reviewed. Special attention is paid to the recently observed relationship between the chemical properties of materials (which are determined by the structure of the valence electron shells) and the peculiarities of the absorption of mesons by nuclei in these materials. (auth)

41290 (JINR-P13-3870) SOME PECULIARITIES OF π^--MESON CAPTURE BY HYDROGEN IN CHEMICAL COMPOUNDS. Krumshtein, Z. V.; Petrukhin, V. I.; Ponomarev, L. I.; Prokoshkin, Yu. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 11p. (In Russian). Dep.

The probability of the π^--meson capture by hydrogen in different chemical compounds (alkalies, salts, and pseudohydrides) has been measured. The obtained experimental results are well explained within the large-mesic-molecules model. In the case of compounds with q identical groups containing hydrogen, the probability of π^--meson capture by bound hydrogen is suppressed by a factor of q at the expense of quantum mechanical resonance. The probability of π^--meson capture in pseudohydrides is considerably less than in normal hydrides and this indicates that the structure of pseudohydrides is complex. (auth)

41291 (N–68-17898) EXPERIMENTAL STUDY OF TRANSMISSION AND BACKSCATTER OF 0.075 TO 1.0 MeV ELECTRONS BY ALUMINUM AND STAINLESS STEEL. Miller, William E.; Hendricks, Herbert D. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Mar. 1968. 22p. (NASA-TN-D-4363). CFSTI.

An experimental study of the transmission and backscatter coefficients for aluminum and stainless steel irradiated with 75-keV to 1-MeV electrons at normal and 45° incidence is reported. The transmission coefficients were greater and the backscatter coefficients were smaller at normal beam incidence than they were at 45° beam incidence for both materials. In all cases the aluminum had higher transmission coefficients and lower backscatter coefficients than did stainless steel. It was determined that the transmission and backscatter coefficients for both aluminum and stainless steel were independent of the number of layers of foils used to attain a given thickness. The ratio of the thickness for maximum backscatter to the extrapolated range was found to be nearly a constant for each material. Transmission curves independent of energy were constructed for aluminum and stainless steel for normal and 45° beam incidence. (auth) (STAR)

41292 (N–68-22388) EXCITATION AND IONIZATION OF POSITIVE HELIUM ION (IS) BY ELECTRON IMPACT. Kyle, H. Lee; Omidvar, K. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1968. 10p. (NASA-TM-X-63182; X-641-68-151). CFSTI.

The binary collision approximation has produced satisfactory agreement between theory and experiment for excitation and ionization of neutral atoms by electrons, especially for the intermediate and high incident energies. It is of interest to test the validity of the theory for excitation and ionization of ions by electrons. In this paper the theory has been applied to such processes for He^+. (auth) (STAR)

41293 (NP–17519) NEKOTORYE VOPROSY TEORII VOZBUZHDENIYA KOLEBATEL'NYKH I VRASHCHATEL'NYKH SOSTOYANII DVUKHATOMNYKH MOLEKUL. (Some Questions on the Theory of Excitation of Oscillatory and Rotating States of Diatomic Molecules). Oksyuk, Yu. D. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 88p. (In Russian). Dep.

Thesis.

Oscillatory and rotational states of diatomic molecules are of great importance for the study of the kinetics of relaxation phenomena in gases, aerodynamics at supersonic velocities, low-temperature plasma, elementary processes in the upper atmosphere, etc. For these reasons, the effective cross section of vibrational and rotational transitions resulting from collision of molecules with electrons was investigated, extending the Born–Oppenheimer approximation to the range of continuous spectra, and determining the effective excitation cross section of these states, as they relate to the dissociation of molecules by collision with heavy particles and in the β decay. By using the adiabatic approximation for examining the collision of molecules with electrons, a generalized expression was obtained for the determination of the effective cross section of these transitions in diatomic molecules at the ground electron state; the same approximation was also applied to calculate the various rotational transitions of N_2, H_2, and O_2 molecules in the 0- to 25-eV range. The results made it possible to clarify experimental data of electron scattering in molecular gases. Similarly, the effective cross section of excitation of these states, and dissociation of N_2, NaCl, and HgH molecules for x collision with heavy particles was also calculated. (Dissertation, 130 references) (TTT)

41294 (NRC–TT–1312) FOCUSING A MOLECULAR BEAM BY MEANS OF A HETEROGENEOUS MAGNETIC FIELD. Korsunskii, M. I.; Fogel, I. M. Translated by G. Belkov for National Research Council of Canada, Ottawa, from Zh. Eksp. Teor. Fiz., 21: 25-37(1951). 16p. Dep. CAN.
physics (particle); translations 20H

Various types of heterogeneous magnetic fields permitting double focusing of a molecular beam are indicated, and the motion of molecules in these fields, taking into account the effect of the force of gravity, was considered. It is shown that it is possible to make a lens for molecular beams by means of a plane heterogeneous magnetic field. (auth)

41295 (ORNL–TM–2072) ELECTRON MEAN FREE PATHS IN A FREE ELECTRON GAS. Hamm, R. N.; Ritchie, R. H.; Ashley, J. C. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 74p. Dep. CFSTI.

Thesis. Submitted by R. N. Hamm to Univ. of Tennessee, Knoxville.

The scattering of an incident electron with an electron lying in the Fermi sea is considered. The incident electron and the struck electron which is ejected from the Fermi sea may then scatter from each other repeatedly. Matrix elements for these scatterings are written down using the techniques of many-body perturbation theory. The exclusion principle is taken into account explicitly for each scattering event, since the particles after the collision must both be found outside the Fermi sphere in momentum space. The resulting expansion for the matrix element is seen to be a Neumann expansion for the solution of an integro-differential equation in momentum-space. Following Bethe and Goldstone this equation is converted into a Schroedinger-like wave equation in configuration space in which an integral operator contains the effect of the exclusion principle. The equation is solved numerically and the scattering cross section is calculated from the s-wave phase shifts. It is determined if this method yields an appreciable correction to the mean free path. (auth)

41296 EXCITATION OF ATOMS BY ELECTRON IMPACT. Nakamura, Hiroki (Tokyo Univ.). J. Phys. Soc. Jap., 25: 519-29(Aug. 1968).

Excitation of atoms by electron impact is investigated theoretically by use of the total angular momentum representation. The mathematical method described in the author's previous

paper is used. The exchange effect is neglected throughout the paper. A new cross-section formula is derived in the two-state approximation. This formula is more accurate than the usual distorted wave (DW) one. In a certain limiting case this coincides with the corresponding B II approximation proposed by Seaton (the Born approximation for the reactance matrix). Furthermore by extending the method to a three-state case some allowance is made for effects of an intermediate state. The new expression for the cross section is again obtained. (auth)

41297 ELASTIC SCATTERING OF ELECTRONS BY XENON ATOMS. Karaivanov, Veselin. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 293-301(1968). (In Russian).

The unmodified Thomas–Fermi potential is used to calculate the effective total cross section and the effective differential cross section for scattering of electrons by xenon atoms for incident-electron energies of 2.35, 42, and 202 eV. The calculation is carried out by numerical resolution of the corresponding radial equations. (tr-auth)

41298 ISOTOPIC SHIFT IN THE DYSPROSIUM SPECTRUM. Pacheva, I.; Abadzhieva, L. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 87-93(1968). (In Russian).

The isotopic shifts of the lines λ 3531.7 Å, λ 3862.12 Å, and λ 3931.55 Å of Dy II were investigated. The distance between the components corresponding to the even isotopes is measured. A violation of the equidistance between the intervals $\Delta\nu(160-162)$ and $\Delta\nu(162-164)$ is estimated. The mean value for the three measured lines of the ratio $\Delta\nu(160-162) : \Delta\nu(162-164)$ is 1.16. The deflection from the equidistant positions of the even components is explained in terms of the peculiarity in the change of the statistical nuclear deformation of the different dysprosium isotopes. (auth)

41299 LUMINESCENCE OF PARTICLES PRODUCED IN THE PROCESS OF SCATTERING OF HYDROGEN IONS AT THE SURFACE OF METALLIC TARGETS. Gritsyna, V. V.; Kijan, T. S.; Koval, A. G.; Fogel, Ya. M. (Kharkov State Univ.). Phys. Lett., 27A: 292-3(July 15, 1968).

It is shown that the luminous region, which arises near the metallic target bombarded by hydrogen ions, is formed by fast excited hydrogen atoms produced in the process of inelastic scattering of hydrogen ions in collisions with superficial atoms of the target. (auth)

41300 SPIN-CHANGE COLLISIONS IN CROSSED ATOMIC BEAMS. Beck, D.; Henkel, U.; Schultz, A. (Univ., Freiburg i. B.). Phys. Lett., 27A: 277-8(July 15, 1968).

The exchange of the (electronic) spin between K and Cs atoms in thermal energy collisions has been observed. The angular distribution of spin changed K atoms is reported from 2.0 to 20 degrees CMS at a collision energy of 2.3×10^{-13} erg. Preliminary attempts to analyze the data yield reasonable numbers for the KCs ($^3\Sigma$) interaction. (auth)

41301 NEUTRALIZATION OF SPACE CHARGE IN AN ION BEAM BY INJECTION OF THERMIONIC ELECTRONS. Spiess, G.; Bonnal, J. F.; Manus, C. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett., 27A: 312-13(July 15, 1968). (In French).

By measuring the ion time of flight in a pulsed beam (Hg^+) ejected from an electron bombardment source, it is shown that the potential wall, resulting from positive space charge, vanishes when electrons are injected into the beam from a hot emissive filament located close to the source. (auth)

41302 OSCILLATING BEHAVIOR OF ELECTRON STOPPING POWER. Bhalla, C. P.; Bradford, J. N. (Kansas State Univ., Manhattan). Phys. Lett., 27A: 318-19(July 15, 1968).

The electron stopping power is calculated by including effects due to the interaction volume and the effective atomic number. Numerical results for amorphous carbon show agreement with experiments. (auth)

41303 ANGULAR DISTRIBUTION OF ANNIHILATIVE γ QUANTA OBTAINED BY POSITRON ANNIHILATION IN INDIUM AND ANTIMONY. Marinov, Marin; Popova, Aleksandra; Dyakov, Tan'o; Damyanov, Stanko. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 111-15(1968). (In Russian).

The angular distribution of annihilative gamma quanta obtained by annihilation of positrons in indium and antimony is studied. It is found that the curve of angular distribution for indium has better-expressed low parts and is bell-shaped. The corresponding curve for antimony is nearer to a parabola. It is estimated that this difference is due to the different number of electrons in the last electron shell. (auth)

41304 POLARIZATION OF RADIATION FROM MOLECULES EXCITED BY ELECTRON IMPACT. Kelley, Ralph E. (Air Force Office of Scientific Research, Washington, D. C.). Res. Rev. (Office Aerosp. Res.), 7: No. 2, 14-15(Feb. 1968).

Excitation and polarization curves are given for measurements of the polarization of the orthohydrogen emission lines at λ = 6226 Å, corresponding to the first rotational Q branch transition from the $^3\pi_u$ (1s 3p) $\rightarrow$ $^3\Sigma_g$ (1s 2s) electron states. (TSS)

41305 Z_1 DEPENDENCE OF ELECTRONIC STOPPING. Cheshire, I. M.; Dearnaley, G.; Poate, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 27A: 304-5(July 15, 1968).

The oscillation of the electronic stopping cross section as a function of Z_1 is obtained as an ionic size effect within the framework of the Firsov model. (auth)

41306 EXACT FORMAL SOLUTION OF THE MANY-CENTER PROBLEM. Kasamanian, Z. H. (Moscow State Univ.). Phys. Lett., 27A: 260-1(July 15, 1968).

An exact formal solution is obtained of a many center problem in the case of an arbitrary spherically symmetrical potential of a single center. (auth)

41307 ABSOLUTE TOTAL COLLISION CROSS SECTIONS FOR MAXWELLIAN BEAMS OF H_2 AND He SCATTERED BY ROOM-TEMPERATURE H_2 AND He. Cantini, P.; Cavallini, M.; Dondi, M. G.; Scoles, G. (CNR, Genoa. Univ., Genoa). Phys. Lett., 27A: 284-5(July 15, 1968).

The absolute values of total collision cross sections for Maxwellian beams of H_2 and He scattered by room temperature H_2 and He are determined. The simple scattering chamber geometry adopted allows for an easy pressure calibration and avoids end corrections to the scattering length. (auth)

41308 CALCULATION OF THE SCATTERING PROBABILITY FOR ELECTRONS BY THE KAPITZA–DIRAC EFFECT. Schoenebeck, H. (Technische Univ., Berlin). Phys. Lett., 27A: 286-7 (July 15, 1968). (In German).

The scattering of electrons by a standing light wave is treated as a wave mechanical problem applying the Born approximation with phase correction. The result is a modification of Kapitza–Dirac's formula at high intensities of light. (auth)

41309 PHOTOIONIZATION OF THE H_2 MOLECULE NEAR THRESHOLD. Chupka, William A.; Berkowitz, Joseph (Argonne National Lab., Ill.). J. Chem. Phys., 48: 5726-8(June 15, 1968).

The relative photoionization and absorption cross sections of ordinary and para hydrogen from 745 to 810 Å at 300°K and at 78°K were measured in the region of ionization threshold. The relative photoionization efficiency as a function of wavelength was obtained for parahydrogen at 78°K. Autoionization lifetimes and efficiencies and the behavior of line intensity were discussed for vibrationally excited states of H_2^+. The ionization potential of H_2 was found to be 124,417 cm^{-1} > I. P. (H_2) > 124,393 cm^{-1} (J.H.R.)

41310 SPECTRA OF N_2 EXCITED BY PROTON BOMBARDMENT. Ghosh, S. N.; Sahai, Y.; Bhutani, K. K. (Univ. of Allahabad, India). Indian J. Pure Appl. Phys., 6: 146-7(Mar. 1968).

N_2 spectra excited by protons of energies in the range 0.56 to 1.7 keV at different N_2 pressures (5 to 30 μ) were studied. Spectroscopic analysis shows that in the region 2900 to 7000 Å, the spectra contain 1PG and 2PG systems of N_2, 1NG system of N_2^+ and H_α and H_β lines. No change in nature of the spectra was observed with change in proton energy. Photometric observations show that the light intensity for 1NG system of N_2^+ varies linearly with the gas pressure while for the 2PG system of N_2 variation is quadratic. The relative band intensities for different progressions and sequence of N_2 and N_2^+ were calculated microphotometrically. Mechanisms for these excitations were proposed. (auth)

41311 DETERMINATION OF FOIL THICKNESS BY BACKSCATTERING OF FAST ELECTRONS. Just, T.; Niedrig, H.; Yersin, H. (Technische Univ., Berlin). Z. Angew. Phys., 25: 89-90(July 1968). (In German).

The backscattering of fast electrons in metal foils proved to be independent of crystal size and foil temperature. Therefore the backscattering is suitable to determine the foil thickness. Appropriate measurements at gold foils (up to 4000 Å) are presented. (auth)

41312 EXCITATION OF THE RESONANCE LINE OF XENON BY ELECTRON IMPACT. Mukhitdinova, I. A.; Yakhontova, V. E. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 232(Mar. 1968).

The excitation of the 1470 Å line of xenon by electron impact was investigated. Excitation curves showing the dependence of the intensity on the energy of the electrons were obtained for different pressures. (J.H.R.)

41313 INVESTIGATIONS ON THE BALMER LINES OF DEUTERIUM. Csillag, L. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 24: No. 1, 1-18(1968).

The wavelengths of the apparent doublet components of six Balmer lines of deuterium were accurately measured with the use of a Fabry–Perot interferometer From the wavelengths of the lines $D_\beta - D_\gamma$ the value of the Rydberg constant was computed. The result obtained $R_D = 109707{,}417 \pm 0{,}003\ cm^{-1}$is in close agreement with the value so far accepted. (auth)

41314 MOLECULAR BEAM KINETICS: REACTIONS OF K, Rb, AND Cs WITH Cl_2. Grice, R.; Empedocles, P. B. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 48: 5352-7(June 15, 1968).

Crossed beam studies were made of the reactions of K, Rb, and Cs atoms with Cl_2. These systems are found to exhibit the "stripping" reaction characteristics previously observed for the M + Br_2 and I_2 systems: (1) the reaction cross sections are very large, ≳150 Å^2; (2) most of the alkali halide product recoils into the forward hemisphere with respect to the incident alkali beam, with scattering angle $\theta < 60°$ (in the center-of-mass system). However, there also seems to be substantial intensity (~5 to 15% of the forward peak) throughout the backward hemisphere, $90° < \theta < 180°$. The sharpness of this forward peaking appears to decrease along the sequence Cl_2, Br_2, I_2 and to be relatively independent of the alkali atom; (3) the angular distribution (in the c.m. system) of alkali atoms scattered without reaction falls off much more rapidly at wide angles than for collisions between unreactive molecules of comparable size. The falloff is most rapid for K + Cl_2 and somewhat less rapid for Rb and Cs + Cl_2, which are roughly comparable with M + Br_2; (4) most of the chemical energy released appears as internal excitation of the products, and other evidence indicates that this is predominantly vibrational excitation of the newly formed bond. (auth)

41315 ELECTRICAL PROPERTIES OF A FAST ARGON ATOMIC BEAM GENERATED BY AN ARC SOURCES. Kessler, R. W.; Obert, W. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Angew. Phys., 25: 71-4(July 1968). (In German).

The fast atomic beam skimmed from the supersonic beam of an arc source still contains a small fraction of plasma (order of 0.01%), permitting an electrical current to flow between the orifice system and an electrode placed in the path of the atomic beam. At sufficiently high positive electrode potential with respect to the orifice system the current flows in the form of periodic pulses. This effect can be interpreted as a self-interruption of the current through formation of a plasma-free zone in the vicinity of the last orifice, with the current increasing again as soon as the succeeding plasma flow restores contact with the electrode.—A plasma-free atomic beam is obtained by applying to the last orifice a negative potential with respect to the remaining orifice system. (auth)

41316 DEPOLARIZATION OF RESONANCE FLUORESCENCE DURING ANISOTROPIC COLLISIONS. Rebane, V. N. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 163-6(Mar. 1968).

The depolarization of resonance fluorescence during collision was examined theoretically when there is one preferential direction of collision. It follows from the overall symmetry properties of the problem (independent of the nature of the disturbing particles) that relaxation of the elements of the density matrix of the excited atoms responsible for the electric dipole emission is characterized by 6J different attenuation constants, where J is the internal quantum number of the excited atom. It is demonstrated that excitation by plane-polarized light can produce circularly polarized fluorescence. In the isotropic case, when all collision directions are equally probable, such a change in the nature of the polarization of the light is impossible. The case of fluorescence $^1P_1 \rightarrow {}^1S_0$ is examined in detail. For this case, equations that describe the change in the probability amplitude of an excited atom A^* on collision with neutral atoms or ions B^+, based on the impact parameter model and straight line trajectories, were numerically integrated. The attenuation constants and coefficients that characterize the efficiency of conversion of the incident plane-polarized light to circularly polarized fluorescence were calculated. (auth)

41317 ELLIPTICAL POLARIZATION OF RADIATION FROM RELATIVISTIC ELECTRONS IN A MAGNETIC FIELD. Korolev, F. A.; Kulikov, O. F.; Yarov, A. S. Opt Spectrosc. (USSR) (Engl. Transl.), 24: 166-8(Mar. 1968).

High-speed photography is used to study phase shifts in the polarization components of the synchrotron radiation of electrons. The vertical-angle intensity distribution in the components of circular polarization are obtained for this radiation. (auth)

41318 EFFECT OF THREE-PARTICLE FORCES ON THE HYPERFINE STRUCTURE OF THE HELIUM ATOM. Labzovskii, L. N. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 169-71(Mar. 1968).

It is shown that, in the theory of two-electron atoms, three-particle forces contribute a term of order α^2 to the magnitude of the hyperfine splitting, leading to the so-called diamagnetic correction. Calculations of this correction for the $2\ ^3S_1$ state of the ^{3}He atom differ substantially (in sign and by a factor of 1.5 in absolute value) from the results of the analytic calculation by Sessler and Foley. Possible causes for this discrepancy are discussed. (auth)

41319 SPECTROSCOPIC STUDY OF THE MECHANISM OF FORMATION OF EXCITED MERCURY IONS IN THE POSITIVE COLUMN OF A LOW-PRESSURE DISCHARGE. Varshavskii, S. P.; Penkin, N. P. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 171-5(Mar. 1968).

Translated from Opt. Spektrosk., 24: 327-36(Mar. 1968).

The mechanism of formation of mercury ions in the excited $6\ ^2P_\frac{1}{2}$ state in mercury plasma at vapor pressures of 10^{-3} to 10^{-1} mm and electron concentrations of 4×10^{10} to $3 \times 10^{11}\ cm^{-3}$ was studied. At mercury vapor pressures of about 10^{-2} mm, the excited ions are produced mainly by the collision of electrons with metastable atoms and ions of mercury in the normal $6\ ^2S_\frac{1}{2}$ state. At higher pressures ($p \approx 10^{-1}$ mm), they are formed by the collision of electrons with normal ions. The effective cross section for the formation of excited ions by electron collision with the normal ion is approximately twenty times greater than the effective cross section for the formation of an excited ion by electron collision with a metastable mercury atom. The mercury ion concentrations determined from reabsorption of the 1942 Å ($6\ ^2P_\frac{1}{2} - 6\ ^2S_\frac{1}{2}$) line of Hg II were identical with the electron concentrations measured by the probe method. (auth)

41320 EULER-ANGLE REDUCTION OF THE SCHROEDINGER EQUATION FOR THREE-ELECTRON ATOMS. Kalotas, T.; Lloyd, M. H.; Delvers, L. M. (Univ. of Sussex, Brighton, Eng.). J. Chem. Phys., 48: 5494-5502(June 15, 1968).

A correction is given to a recent Euler-angle classification of the states of three-electron atoms. The nonrelativistic Schrödinger equation for these states is written in terms of the Euler-angle coordinates and the spin–Euler-angle integrations carried out explicitly for a state of arbitrary (J,π). (auth)

41321 EXCITATION ELECTRONIQUE D'UNE VAPEUR ATOMIQUE. APPLICATION A LA SPECTROSCOPIE. (Electronic Excitation of an Atomic Vapor. Application to Spectroscopy). Colloques Internationaux du Centre National de la Recherche Scientifique, No. 162. Paris, Editions du Centre National de la Recherche Scientifique, 1967. 255p. 35 F. (In English and French). (CONF-660512).

Twenty-four papers are presented on the topics: excitation of an atomic vapor by a beam of slow electron—study of the polarization of the emitted light; alignment of an atomic level excited by electron bombardment; excitation of an atomic vapor by ionic collision or in a discharge; and methods of study of atomic levels other than classic spectroscopy. Separate abstracts were prepared for ten of these papers. (M.H.R.)

For abstracts of individual papers see: 41322–41331.

41322 THEORY OF THE POLARIZATION OF ATOMIC LINE RADIATION EXCITED BY ELECTRON IMPACT. Seaton, M. J. (University Coll., London). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 21-33(1967).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

The theory is reviewed with emphasis on physical ideas rather than mathematical formalism. For the particular case corresponding to the high-energy threshold, the percentage polarization can be calculated using only the laws of conservation. The effect of fine and hyperfine structure on reduction of percentage polarization is examined, as well as the particular case of the hydrogen atom. (M.H.R.)

41323 A REVIEW OF THE MEASUREMENTS OF ELECTRON-INDUCED POLARIZED OPTICAL RADIATION NEAR THRESHOLD. McFarland, Robert H. (Univ. of California, Livermore). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 35-50(1967).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

Experiments performed to determine the percentage polarization of light emitted after electronic excitation of helium in the vicinity of the excitation threshold are reviewed. With improved energy resolution and signal-to-noise ratio, theory and experiment were brought into closer coincidence by showing threshold polarization of some lines previously thought to have been zero to be nonzero. (M.H.R.)

41324 CROSS SECTION OF THE HYDROGEN $2^2\ S_\frac{1}{2}$ STATE AND EXCITATION FUNCTION AND POLARIZATION OF THE H_α AND H_β LINE BY ELECTRON IMPACT EXCITEMENT. Klein-

poppen, H.; Krueger, H. (Univ., Tuebingen, Ger.). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 61-8(1967).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

Some electron–hydrogen crossed-beam experiments were reported. The cross section [$\sigma(1S,2S)$] of the H($2^2S_{\frac{1}{2}}$) state was measured from 10.2 eV to 500 eV. Further improved results were obtained for the total Hα excitation function and Hα polarization. Preliminary measurements were made on the Hβ line. (M.H.R.)

41325 ELECTRON BOMBARDMENT METHOD OF STUDY OF EXCITED ATOMIC LEVELS. Pebay-Peyroula, J. C.; Chenevier, M.; Goullet, G. (Faculte des Sciences, Grenoble, France). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 71-93 (1967). (In French).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

By the selective excitation of Zeeman sublevels of an atomic vapor, different resonant states can be observed; this yields data on the excited states. The principles used are discussed, with a consideration of the excited vapor, magnetic resonance experiments, experiments concerning an initially transverse alignment, and specific aspects of electron excitation. The experimental techniques and methods are described. The application of the electron excitation method to the spectroscopic study of levels and to the study of excitation processes during electron bombardment. The latter was illustrated by a study of the 6 $^3D_3$ level of Hg. (J.S.R.)

41326 EXPERIMENTS ON ELECTRONIC EXCITATION OF ATOMS PERFORMED AT LAWRENCE RADIATION LABORATORY, BERKELEY, CALIFORNIA, U.S.A. Hadeishi, Tetsuo (Univ. of California, Berkeley). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 105-15(1967).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

A brief survey of the experiment on electronic excitation of atoms, carried on at the Atomic Beam Group of the Lawrence Radiation Laboratory, is made. By means of alignment of excited atoms by electron-impact excitation, rf paramagnetic-resonance reorientation of Hg and Ne metastable states was first observed. Later on, the method was extended to observe the coherence property of excited atoms associated with the electron-impact excitation. The coherent excitation of nondegenerate levels of excited atoms results in intensity beats either in the fluorescent decay due to spontaneous radiation or in the resonance absorption by a long-lived metastable state. (auth)

41327 MEASUREMENT BY LEVEL CROSSINGS OF STRUCTURES OF ^{4}He AND ^{3}He ATOMS EXCITED BY ELECTRON IMPACT. Descoubes, J. P.; Galleron, C.; Maujean, M. (Lab. de Physique de l'Ecole Normale Superieure, Paris). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 117-29(1967). (In French).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

The principle of the level crossing method and the conditions for electron excitation are described. The experimental method used in the study of the structures of ^{4}He and ^{3}He is discussed. The results obtained on the fine structure, hyperfine structure, and lifetimes of the excited levels are tabulated. The relative intensity of the curves was calculated, and the theoretical curves obtained are compared with the experimental results. (J.S.R.)

41328 EXCITATION OF ATOMS IN THE CASE OF IONIC IMPACT. de Heer, F. J.; Van Den Bos, J. (Laboratorium voor Massascheiding, Amsterdam). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 145-59(1967).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

The bombardment of helium atoms by a beam of protons or helium ions is studied. In order to get an insight into the general behavior of excitation cross sections, different reactions are discussed. Examples are: direct excitation ($H^+ + He \rightarrow H^+ + He^*$) and capture of an electron into an excited state ($H^+ + He \rightarrow H^* + He^+$). Many reactions for protons or helium ions incident on helium are considered, because in this case many experimental results are available. Apart from this it is easy to make an experimental separation between S, P, and D states of the helium atom. For protons incident on atomic hydrogen, many more theoretical calculations are available than on helium. For a qualitative understanding of the general behavior of excitation cross sections, these theoretical calculations are representative for many reactions and are compared with the experimental results for helium. (M.H.R.)

41329 ALIGNMENT OF EXCITED LEVELS OF AN ATOMIC VAPOR IN A HIGH FREQUENCY DISCHARGE. Lombardi, M. (Faculte des Sciences, Grenoble, France). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 161-5(1967). (In French).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

The principle of the device developed for the alignment of excited levels of an atomic vapor in a high-frequency discharge is described. The device is being tested by studying various rays of helium by Henle effect and magnetic resonance. Some preliminary curves obtained are given. (J.S.R.)

41330 THE EVOLUTION OF LIFE-TIME MEASURING TECHNIQUES AT THE UNIVERSITY OF OKLAHOMA. Holzberlein, T. M. (Principia Coll., Elsah, Ill.). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 193-201(1967).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

The technological stages of measuring the lifetime by observation of decay curves of light emitted after the excitation stops. In order to obtain enough light intensity, it was necessary to construct excitation tubes with a high current intensity (5 A). Diagrams of three of the tubes used successively are given. The pulse generator employed utilizes a gas thyratron generator and a delay line where the parameters vary along 18 elementary cells. The observations were made with the aid of a photomultiplier fed by very high-voltage pulses and an oscillograph where the trace is photographed. The equipment was used to measure the lifetime of the helium atoms and to show the phenomena of radiation imprisonment. This equipment can be used on very weak lines. (M.H.R.)

41331 RADIATIVE LIFETIMES BY ELECTRON COLLISION USING THE PHASE SHIFT METHOD. Lawrence, G. M. (Princeton Univ., N. J.). Colloq. Int. Cent. Nat. Rech. Sci., No. 162, 239-45(1967).

From Electron Excitation of Atomic Vapor, Applications to Spectroscopy Seminar, Grenoble, France. See CONF-660512.

The phase-shift method obtains information on the time behavior of a system of radiating particles by modulating the excitation sinusoidally. The modulation of the emitted light has a phase delay which is determined and yields the desired information. The nature of the information contained in the phase-shift data and the unique features of this version of the method are discussed. Among these are: excitation by an electron beam with modulated current, cascade effects and their correction, elimination of accidental phase shifts by calibration of the equipment by comparison with the known Lyman-alpha lifetime. The lifetime resolution with this equipment is of the order of 0.2 nsec. Results are given for the transitions of boron, carbon, nitrogen, silicon, sulfur, phosphorus, oxygen, neon, and argon. (M.H.R.)

41332 NEW INTERATOMIC POTENTIAL FUNCTION FOR HELIUM. Beck, D. E. (St. Andrews Univ., Scotland). Mol. Phys., 14: 311-15(1968).

A new interatomic potential for helium is proposed of the form: $v(r) = A \exp(-\alpha r - \beta r^6) - 0.869/(r^2 + a^2)^3 [1 + (2.709 + 3a^2/r^2 + a^2)]$, with $a = 0.675$ Å, $\alpha = 4.390$ Å^{-1}, $\beta = 3.746 \times 10^{-4}$ Å^{-6} and $A = 398.7$ eV. The long-range attraction has the correct theoretical dependence on the separation with the terms having the coefficients as calculated by Dalgarno and Kingston (Proc. Phys. Soc., 78: 607 (1961)) and by Davison (Proc. Phys. Soc., 87: 133(1966)). The short-range repulsive part of the potential was fitted to the calculated potential energy values of Phillipson (Phys. Rev., 125: 1981(1962)) and the experimentally determined values of Amdur and his coworkers (J. Chem. Phys., 46: 165(1967)); 34: 1525(1961), and 22: 664(1954)). In addition the parameters were adjusted so that the potential reproduces the experimentally determined second virial coefficient for helium. (auth) (UK)

41333 THIRD-ORDER INTERACTION ENERGY BETWEEN ATOMS. Chan, Y. M. (Univ. of Malaysia, Kuala Lumpur); Dalgarno, A. Mol. Phys., 14: 101-4(1968).

A new method is described for calculating high-order interaction energies of a pair of atoms separated by large distances R. It is applied to a pair of ground-state hydrogen atoms with the result that the leading term of the third-order interaction energy is $-3986/R^{11}$ in atomic units. (auth) (UK)

41334 SCATTERING OF LOW-ENERGY HYDROGEN IONS (H_1^+, H_2^+ AND H_3^+) AND ATOMS (H_1^0) FROM EVAPORATED METALLIC FILMS. Morita, Kenji; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). Jap. J. Appl. Phys., 7: 916-26(Aug. 1968).

Scattering and charge exchange at the metal surface of H_1^+, H_2^+, H_3^+ and H_1^0 with energies between 6 and 40 keV were measured. It was found that the energy spectra and intensities of scattered protons are the same for four kinds of the projectiles (H_1^+, H_2^+, H_3^+ and H_1^0) when the velocities of the incident projectiles were the same.

The peak energy and the FWHM of the energy distribution curve of emergent protons increase with increasing incident energy. The integrated intensity of emergent protons increases linearly with increasing energy at the low energy region and tends to saturate gradually at the high energy. The experimental results obtained, including the result of the angular distribution, are discussed by using the "one deflection model" by considering the charge-exchange collisions and the electronic energy loss of proton. (auth)

41335 OPTICAL ABSORPTION SPECTRUM OF TRAPPED DIELECTRONS IN ALKALINE ICE. Kevan, L.; Renneke, D. R.; Friauf, R. J. (Univ. of Kansas, Lawrence). Contract AT(11-1)-1197. Solid State Commun., 6: 469-71(July 1968). (COO-1197-29).

For γ-radiation doses greater than 10 MR the single electron (e_f^-) band of NaOH ice at 585 nm decreases, and a very broad band grows in the near ir with a maximum at approximately 1000 nm. Bleaching at 585 nm causes further growth of the ir band. These results agree with the simultaneous decrease of the e_f^- EPR signal. A model for the ir band comprising two electrons trapped in the same vacancy (e_{f2}^-), in analogy to the F' center in alkali halides, is suggested. (auth) (UK)

41336 THE OSCILLATOR STRENGTH OF THE MOLECULAR HYDROGEN (4,0) LYMAN BAND. Hesser, James E.; Brooks, Neil H.; Lawrence, George M. (Princeton Univ., N. J.). Astrophys. J., 153: L65-6(July 1968).

An absolute absorption measurement of the $H_2B\ ^1\Sigma_u^+ \leftarrow X\ ^1\Sigma_g^+$ (4,0) band oscillator strength was performed under high resolution with the result that $f(4,0) = 0.030 \pm 0.007$. (auth)

41337 THEORETICAL AND NUMERICAL STUDY OF THE 1s-2s EXCITATION OF ATOMIC HYDROGEN BY SLOW ELECTRONS. Kolodziejski, R. (Inst. of Physics, Warsaw). Acta Phys. Pol., 33: 991-1006(June 1968).

An approximate method is applied in calculations of the partial and total cross sections for the 1s-2s excitation of atomic hydrogen by slow electrons. The method takes into account the spherically symmetrical part of the distortion of the hydrogen atom due to the incoming electron and the distortion of the incoming electron's wave function. The values of zero-order (L = 0) partial cross sections obtained by this method are nearer to the values obtained from the close-coupling method than the values given by the Born approximation. For increasing angular momentum quantum numbers of the incoming electron the partial cross sections calculated by the method used in this paper and the Born approximation decrease too fast in comparison with the close coupling results. A possible further application of the theoretical results is indicated. (auth)

41338 f-VALUES OF BANDS OF THE CARBON MONOXIDE FOURTH POSITIVE SYSTEM. Rich, John C. (Harvard College Observatory, Cambridge, Mass.). Astrophys. J., 153: 327-9 (July 1968).

Goldberg, Parkinson, and Reeves (1965) identified several bands of the CO fourth positive ($A^1\Pi - X^1\Sigma^+$) system in absorption in the solar ultraviolet spectrum between λ1596 and λ1912. This note reports additional experimental results obtained by using a shock tube. The driver gas was hydrogen and the low-pressure gas was commercial argon to which small percentages of CO and $Cr(CO)_6$ were added. (W.D.M.)

41339 COMPETITION BETWEEN RANDOM AND PREFERENTIAL EJECTION IN HIGH-YIELD MERCURY-ION SPUTTERING. Musket, Ronald G.; Smith, Harold P. Jr. (Univ. of California, Berkeley). J. Appl. Phys., 39: 3579-86(July 1968).

A radioactive tracer technique was employed to determine the yield (atoms/ion) and angular distribution (atoms/ion sterad) of atoms sputtered from Cu (100) and Mo (100) surfaces by a 1- to 10-keV Hg^+-ion beam. Values of the yield for Ni (100) surfaces were also determined. Analytical models for normal and oblique ion incidence cases were fitted to the angular distribution data. The functions describing the preferential emission in the closest-packed direction and the [100] direction were Gaussians, whereas the background distribution was represented by a cosine, which was tilted away from the surface normal for oblique incidence. Integration of the total distribution gave the relative contributions to the sputtering yield of the directed emissions and background. In all cases, the cosine contribution, which is interpreted in terms of emission from a random lattice, accounted for more than $\frac{2}{3}$ of the atoms sputtered. However, intense Wehner spots were present even when the cosine distribution accounted for $\frac{4}{5}$ of the ejections. These spots, which are commonly attributed to preferential ejections, are more accurately interpreted as a combination of random emission and collimated preferential emission. (auth)

41340 ELECTRON ATTACHMENT IN IONIZED FLOWS AT ELEVATED GAS TEMPERATURES. Malliaris, A. C. (Avco Corp., Wilmington, Mass.). J. Appl. Phys., 39: 3675-82(July 1968).

An ionized argon flow (electron concentration of the order of 10^{12} per cm^3), at elevated gas temperatures, is obtained by arc heating. The flow is admitted in a mixing chamber where small additive fractions (order of 10^{-4}) of an electrophilic compound (SF_6) are injected into and mixed with the flow. The mixtures are incubated under specified incubation conditions (3000° to 5000°K, 0.1 to 1 atm, 10^{-3} to 10^{-4} sec). Electron and ion concentrations are determined at the end of the incubation and for this, both single and double Langmuir probes are used. Auxiliary probing is also carried out by an x-band microwave beam. Suppression of the electron concentration by factors ranging from 2 to over 1000 are determined, depending on experimental conditions. By experimental evidence it is demonstrated that the suppression of the electron concentration is the result of negative ion formation and survival. Charge neutralization processes are relatively negligible. (auth)

41341 COMPUTER SIMULATION OF SPUTTERING. Harrison, D. E. Jr.; Levy, N. S.; Johnson III, J. P.; Effron, H. M. (Naval Postgraduate School, Monterey, Calif.). J. Appl. Phys., 39: 3742-61(July 1968).

Present computers have neither enough memory capacity nor computation speed to completely simulate the sputtering process. The conclusions reported here were obtained with purely repulsive potential functions. Surface binding energies were included artificially. The simultations produce excellent spot patterns, but only approximately correct sputtering ratios. The Ar^+-Cu system has been studied in detail and a few trials have been made on the Xe^+-Cu system. The three Gibson potentials and the Anderson-Sigmund potential were used for the Cu-Cu interaction. Changing these functions produces quantitatively, but not qualitatively, different results; so a majority of the investigation was conducted with the Gibson II potential. The Ar-Cu and Xe-Cu potentials were those obtained locally from secondary electron emission studies. Variation of parameters in these functions had little effect on the spot patterns. Sputtering ratios change appreciably as the parameters of the potentials are varied, but the unexplained systematic difference between simulation and experiment cannot be removed by parametric variation within a Born-Mayer potential function model. The simulations indicate that sputtering is caused by two mechanisms: (a) In the more common situation the incoming ion strikes two lattice atoms almost simultaneously. The lower energy of these two primary knock-on atoms then initiates the sputtering of several of its neighbors. The higher-energy primary knock-on may also cause some sputtering, but it usually is less efficient because a large fraction of its momentum is directed into the surface. (2) In a relatively small number of events the ion, after having made one or more collisions, is reflected from the second or third layer of the crystal. It then can initiate sputtering as it returns toward the surface. The second mechanism has never been seen when the ion is heavier than the lattice atoms. Primary knock-on ions rarely sputter. Occasionally (after making several collisions) one escapes accidently. Almost every incident ion sputters at least one atom, even those that enter a (110) channel. Ions that hit the end of a (110) chain with zero impact parameter, or ions that penetrate normally into the absolute center of the trigonal lens of the (111) surface or the square lens of the (100) surface do not cause sputtering. Surface dynamics dominate the sputtering process. The probability of focuson sputtering appears to be vanishingly small. The relationships between the surface dynamics, transparency, and channeling models are discussed. (auth)

41342 NORMAL SPECTRAL EMISSIVITY OF Ta-W AND Nb-Mo ALLOYS. Thomas, Ludwig K. (Westinghouse Research and Development Center, Pittsburgh). J. Appl. Phys., 39: 3737-42(July 1968).

Measurements of the normal spectral emissivity of Ta-W and Nb-Mo alloys are reported. The emissivities were measured at 2000°, 2200°, and 2400°K in the wavelength range 0.4 to 4 μm. The emissivities of the alloys generally lie between the values of the pure constituents. The temperature coefficient and the x-point wavelength of Ta-W alloys change in a characteristic way. The measurements support the validity of the rigid band model. (auth)

41343 TWO- AND THREE-PARTICLE COULOMB SYSTEMS. Nutt, Gerald L. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.), 9: 796-803(May 1968).

The Coulomb T matrix is examined in a two-body and a three-body Hilbert space. The purpose is to demonstrate how this function may be used to construct the Faddeev three-body kernel. In the process the apparent paradox of the indefiniteness of the Coulomb T matrix on the energy shell is resolved. The question of off-shell unitarity is discussed. (auth)

41344 EFFECT OF THE ANOMALOUS MAGNETIC MOMENT OF THE ELECTRON ON SPONTANEOUS PAIR PRODUCTION IN A STRONG MAGNETIC FIELD. O'Connell, R. F. (Louisiana State Univ., Baton Rouge. Goddard Space Flight Center, New York). Phys. Rev. Lett., 21: 397-8(Aug. 5, 1968).

Taking into account the anomalous magnetic moment of the electron by adding the so-called Pauli anomalous interaction term to the usual Dirac Hamiltonian for an electron in a constant magnetic field H, it is concluded that spontaneous pair creation may occur for values of H of the order of m^2c^4/e^3, a "critical field" beyond which classical electrodynamics breaks down. (auth)

41345 METHOD FOR MEASURING THE CYCLOTRON AND SPIN RESONANCE OF FREE ELECTRONS. Graff, G.; Major, F. G.; Roeder, R. W. H.; Werth, G. (Univ., Bonn). Phys. Rev. Lett., 21: 340-2(Aug. 5, 1968).

The cyclotron and spin resonances of free electrons field confined in a small volume in ultrahigh vacuum were observed via the rapid loss of electrons when their cyclotron motion was excited by the rf field and spin-dependent collision processes with polarized Na atoms in a beam, respectively. The electrons were polarized by spin exchange and then monitored through the spin dependence of the excitation process $e + Na(3S) \rightarrow e + Na^*(3P)$ and hence of their cooling rate. (auth)

41346 ENERGIES AND LIFETIMES OF THE METASTABLE AUTOIONIZING $(1s2s2p)\ ^4P_J$ STATES OF ^6Li AND ^7Li; ASSIGNMENT OF Li-I_b QUARTET LINES. Feldman, P.; Levitt, M.; Novick, R. (Columbia Univ., New York). Phys. Rev. Lett., 21: 331-5(Aug. 5, 1968).

A Zeeman-quenching atomic-beam method was developed and used for the determinations of the energies and lifetimes of the metastable autoionizing $(1s2s2p)\ ^4P$ states of ^6Li and ^7Li. The values obtained for certain of these parameters are in serious disagreement with existing theoretical estimates. The energy values were used for the definitive identification of previously unassigned lines in the Li spectrum. (auth)

41347 PHOTOELECTRIC CROSS SECTIONS OF GAMMA RAYS IN Sn, W, Au, Pb, AND U: A COMPARISON OF MCCRARY ET AL.'S RESULTS WITH CALCULATED AND COMPILED VALUES. Parthasaradhi, K. (Andhra Univ., Waltair, India). Nuovo Cim., 56B: 279-82(Aug. 11, 1968).

Total photoelectric cross sections of gamma rays were determined by subtracting the theoretical scattering cross sections from total experimental gamma-ray cross sections in elements Sn, W, Au, Pb, and U at 30, 40, and 50 keV. Agreement is observed between these values and the theoretical values of Schmickley and Pratt, Rakavy and Ron and that of Hubbell and Berger, within the range of errors, except in Au at 30 and 50 keV and in Pb at 30 and 40 keV, where the discrepancy is within 4% exceeding the errors. (auth)

41348 LOWER-BOUND PROPERTY OF ADIABATIC PHASE SHIFTS. Coulson, C. A.; Gerber, R. B. (Oxford Univ.). Mol. Phys., 14: 117-31(1968).

In molecular encounters the total energy of the system may not be sufficient to enable any but the ground-state electronic surface to determine nuclear motions adiabatically. When this happens, nonadiabatic transitions are energetically forbidden. It is shown that for such collisions the phase shifts computed in the adiabatic approximation are lower bounds to the exact phase shifts. The proof derives from a study of the non-local potential which arises when the exact collision problem is transformed so as to involve only nuclear motion explicitly. Use is made of a well-known relation between magnitudes of effective potentials and of phase shifts associated with two respective Hamiltonians. This result is related to a theorem by Hahn et al. (Phys. Rev. 128: 932 (1962)). The similarities and differences between the two are discussed. (auth) (UK)

41349 ACCURATE FITTING OF INTERATOMIC POTENTIAL FROM SCATTERING: ALKALI METAL–RARE GAS SYSTEMS. Dueren, R.; Raabe, G. P.; Schlier, Ch. (Univ., Freiburg i. B.). Z. Phys., 214: 410-21(1968). (In German).

Recent improvements in precision and the increase in number of molecular beam scattering experiments demand a reanalysis of the experimental data. The commonly used potential functions show a serious lack of flexibility, and fitting procedures are not unambiguous. A new potential ansatz (which is a continuous modification of the (12–6)-potential) was used to fit all available data on the alkali-metal–rare gas systems Li–Kr, Na–Ar, Na–Kr, Na–Xe, K–Ar, and K–Kr. A χ^2-minimum method is used as the procedure to fit the data and to estimate the errors of the parameters obtained. It turns out that the shape of the potential is similar for all systems evaluated here but probably different from that derived for rare gas–rare gas systems. (auth)

41350 SHORT-LIVED COMPOUND STATES IN THE SCATTERING OF SLOW ELECTRONS BY HELIUM. Andrick, D.; Ehrhardt, H.; Eyb, M. (Univ., Freiburg i. B.). Z. Phys., 214: 388-401(1968). (In German).

Electron scattering measurements were made of the energy dependences of the excitation of the helium $2\ ^3S$, $2\ ^1S$, $2\ ^3P$, and $2\ ^1P$ states at different scattering angles in the range from 20 to 145°. In the energy range from 22 to 23 eV five overlapping resonances of the (e–He)-system were determined, one of which (22.42 eV) is identified to be a $3\ ^2S$, another (22.60 eV) a $3\ ^2P$-state. The energy values of the other resonances are resp. 22.55, 22.75, and 22.85 eV. The half-widths are below approximately 40 meV. In the $2\ ^3P$-channel three peaks vanish at the same scattering angle, a fact, which seems not understandable in terms of first order resonance poles. (auth)

41351 ELASTIC SCATTERING OF SLOW ELECTRONS BY ISOLATED ATOMS UNDERGOING ISOTROPIC THERMAL MOTION. Dvoryankin, V. F.; Mityagin, A. Yu. (Radio Technol. and Electronics Inst., Moscow). Sov. Phys.-Cryst. (Engl. Transl.), 13: 3-6(July-Aug. 1968).

Translated from Kristallografiya, 13: 5-9(Jan.-Feb. 1968).

The Kohn variational principle is used to find an analytic expression for the phase of S-wave scattering in which the temperature is taken into account. To estimate the effect of thermal motion on the phase of the scattering, a numerical calculation is carried out of the phase of S-wave scattering for a nitrogen atom with $B = 0$ Å^2 and $B = 4$ Å^2, for $k^2 = 0.05$ and $k^2 = 1$. (auth)

41352 INVESTIGATION OF THE ELEMENTARY PROCESS OF BREMSSTRAHLUNG PRODUCTION BY COINCIDENCE EXPERIMENTS. Nakel, Werner (Univ., Tuebingen, Ger.). Z. Phys., 214: 168-78(1968). (In German).

By using a coincidence method, the angular distribution of bremsstrahlung was measured for definite energy loss and definite angle of the outgoing electron. The incident electron energy was 300 keV. With a magnetic spectrometer, outgoing electrons with an energy of 170 keV and scattering angles of 0, 5 and 10° were selected. The electrons and photons were both detected in scintillation counters. A gold foil of 250 Å thickness served as the target. The experimental results are compared with theoretical calculations. (auth)

41353 DIFFERENTIAL EXCITATION FUNCTIONS OF THE N = 2 STATES OF HELIUM. Ehrhardt, H.; Langhans, L.; Linder, F. (Univ., Freiburg i.B.). Z. Phys., 214: 179-94 (1968). (In German).

Energy and angular dependences for the electron impact excitation of the helium $2\ ^3S$, $2\ ^1S$, $2\ ^3P$, and $2\ ^1P$ states were measured using monochromatic (0.05 eV) electrons in the energy range from 19 to 23 eV and for scattering angles ranging from 0 to 110°. The structures near the $2\ ^3S$ threshold were analyzed in terms of resonant and nonresonant i.e., direct scattering phase shifts. The first peak in this excitation function at 19.95 eV is mostly due to the rapid change with collision energy of the direct s-wave phase of the inelastic scattering, which in turn is a consequence of the existence of the $2\ ^2S$ resonance at 19.3 eV. The energy position and behaviour with collision energy of the first peak at 20.7 eV in the $2\ ^1S$ channel is in agreement with the predictions for the existence of a virtual resonance state of Burke et al. A term scheme of the He^- resonances with assignments of configurations is presented. (auth)

41354 ELECTRON ENERGY LOSS MEASUREMENTS AND CALCULATION OF OPTICAL CONSTANTS. I. SOLID XENON. Keil, P. (Univ., Hamburg). Z. Phys., 214: 251-65(1968). (In German).

Energy loss measurements on solid xenon applying 51-keV electrons are reported. The spectrum shows excitonic structure and a plasma loss. From the energy loss function $-\mathrm{Im}\ 1/\epsilon$ optical constants are calculated by means of a Kramers–Kronig transform. They are compared with optical absorption spectra and found to be in good agreement. An appendix gives detailed information about the calculation of $-\mathrm{Im}\ 1/\epsilon$ from energy loss measurements. (auth)

41355 ELECTRON ENERGY LOSS MEASUREMENTS AND CALCULATION OF OPTICAL CONSTANTS. II. POTASSIUM BROMIDE. Keil, P. (Univ., Hamburg). Z. Phys., 214: 266-84(1968). (In German).

Energy loss measurements on KBr films applying 51-keV electrons are reported. The loss spectrum is interpreted in terms of excitonic structure, interband structure, and plasmons. The temperature dependence concerning position and half width, and the angular dependence of the intensity of different energy losses is investigated. From the loss spectrum the energy loss function — $\mathrm{Im}\ 1/\epsilon$ is calculated. By means of a Kramers–Kronig transform optical constants are calculated from the loss function. Absorption and reflectance, especially, are found to agree very well with optical spectra. (auth)

41356 MANY-BODY APPROACH TO ELECTRON CORRELATION IN ATOMS AND MOLECULES. Freed, Karl F. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 173: 1-24(Sept. 5, 1968).

Many-body perturbation theory (MBPT) is used to investigate the energy, wave function, and two-electron density matrix of a closed-shell atom or molecule when the initial approximation to the wave function is taken in the Hartree–Fock approximation. Since certain classes of terms dominate in all orders of perturbation theory, models are investigated in which certain types of terms are summed to all orders of perturbation theory. The diagrams which are summed are explicitly chosen to provide results in the form of inhomogeneous integrodifferential equations which are as similar as possible to the models used by Kelly, Sinanoğlu, and Nesbet, thereby enabling some comparison to be made between these theories and indicating some of the corrections to them. It is proven that the diagrams approximated by Kelly to all orders of perturbation theory, which have only two electrons excited at a given time, could be calculated from a knowledge of Bethe–Goldstone (BG) pairs, which represent the perturbative corrections for correlation for a pair of electrons moving in the field of the remaining electrons, which are in their ground-state Hartree–Fock (HF) orbitals. The uncoupled linear inhomogeneous equations for the pairs could be solved by the use of a correlated basis set, and their solution can be found variationally, along with the individual pair correlation energies, by varying part of the energy of a simple cluster-type wave function. However, as in the case of the other models, certain variations of part of the energy are shown to be equivalent to the summation of particular classes of diagrams to all orders of perturbation theory. The doubly excited diagrams omitted by the BG pairs arise from the fact that when a pair of electrons are excited out of the HF "sea," the Pauli principle no longer prohibits the remaining electrons from occupying the space left behind by the excited electrons. The inclusion of these exclusion effects results in coupled linear inhomogeneous equations for the new pair-correlation correction functions. Single and triple excitations modify the pair equations by the inclusion of a two-body potential, respectively, describing the virtual de-excitation of one of the two correlating electrons and virtual excitations of a third electron in the field of the two correlating electrons. Alternatively, coupled linear inhomogeneous equations can be written for the one-, two-, and three-electron cluster functions, and these equations may be solved variationally. The generalization of the above results to cover the case in which the zeroth-order wave function is a single Slater determinant of arbitrary orthonormal spin orbitals (as well as a treatment of the higher excitations) is presented in the following paper. In the appendix, a discussion is presented to indicate the connection between what Sinanoğlu calls "unliked clusters" and the diagrams of MBPT. (auth)

41357 GENERALIZED PERTURBATION THEORY AND ITS APPLICATION TO THE PROBLEM OF THE DESCRIPTION OF ELECTRON CORRELATION IN ATOMS AND MOLECULES. Freed, Karl F. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 173: 24-33(Sept. 5, 1968).

For the case in which the zeroth-order wave function is a single Slater determinant of arbitrary orthonormal spin-orbitals, the exact wave function can be expressed in terms of a cluster-type expansion. If perturbation theory is applied in the standard (and systematic) fashion to the Schrödinger equation for the cluster functions, a generalized form of Rayleigh–Schrödinger perturbation theory (GPT) is obtained. Although GPT is quite flexible, the form presented in this work is chosen so that the terms initially calculated in GPT correspond as closely as possible to the starting points in the theories of Sinanoğlu, Kelly, Conkie, Nesbet, and others. The first-order corrections to the wave function in GPT are written in terms of one- and two-electron functions which respectively describe the perturbative corrections for the motion of one and two electrons in the field of the remaining electrons which are in their groundstate orbitals (i.e., perturbative Bethe–Goldstone-like equations). This is a more physical starting point than the first-order wave function of ordinary Rayleigh–Schrödinger perturbation theory (OPT), and GPT should be much more rapidly convergent than OPT. By analogy with OPT, GPT also has a $2n + 1$ rule, a variational principle for the nth-order energy and the 2^nth-order wave function, and interchange theorems of double-perturbation theory. As in OPT, the equations of GPT can be solved by the use of correlated functions; however, in GPT, H_0 is not required, and the zeroth-order spin-orbitals need not all be eigenfunctions of the same one-electron Hamiltonian. (auth)

41358 ATOMIC TERM PATTERNS. Judd, B. R. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-1447. Phys. Rev., 173: 39-40(Sept. 5, 1968). (NYO–1447-38).

The electrostatic energies of terms of complex configurations can sometimes be understood better by separating the electrons according to their spin orientation and then coupling the two parts. The method is illustrated in detail for the low terms of f^6. (auth)

41359 ATOMIC g ELECTRONS. Judd, B. R. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-1447. Phys. Rev., 173: 40-3(Sept. 5, 1968). (NYO–1447-39).

A scheme is presented for giving a complete classification of the states of the atomic configurations g^N. Repeated terms are separated by diagonalizing an operator e that has, as its analog in the f shell, the operator that classifies states according to the group G_2. Properties of e that are typically group-theoretical in character are noted. Tables of fractional parentage coefficients and the energies of the terms of maximum multiplicity are given. (auth)

41360 REMEASUREMENT OF THE LAMB SHIFT IN D, n = 2. Cosens, B. L. (Yale Univ., New Haven). Phys. Rev., 173: 49-55(Sept. 5, 1968).

The Lamb shift in the n = 2 level of deuterium was measured by locating the crossing point of the levels $2^2S_{\frac{1}{2}}$ ($m_J = -\frac{1}{2}$) and $2^2P_{\frac{1}{2}}$ ($m_J = +\frac{1}{2}$) near 574 G. An atomic beam in the metastable $2^2S_{\frac{1}{2}}$ state was prepared, having a single hyperfine structure component. This beam then traveled into a magnetic field where a static electric field was used to induce transitions to the $2^2P_{\frac{1}{2}}$ ($m_J = +\frac{1}{2}$) state. Transitions utilizing two different hyperfine components were measured, and yielded two independent values of the Lamb shift. Eleven corrections to the data are discussed in some detail. The final value for the Lamb shift is $S_D = 1059.24 \pm 0.10$ MHz. This result disagrees slightly with the original measurement of Lamb et al., but does agree with the most recent theoretical result. (auth)

41361 2Pπ STATES OF MUONIC MOLECULES. Carter, Benjamin P. (Univ. of California, Livermore). Phys. Rev., 173: 55-8(Sept. 5, 1968). (UCRL-70897).

The possible existence of μ-molecular states corresponding to the 2Pπ muon orbital is investigated. Such states are found to be bound in the lowest adiabatic approximation, with levels near the n = 2 atomic levels. (auth)

41362 MAGNETIC INTERACTIONS IN MIXED CONFIGURATIONS. Armstrong, Lloyd Jr. (Westinghouse Research Center, Pittsburgh); Feneuille, S. Phys. Rev., 173: 58-62(Sept. 5, 1968).

Magnetic interactions for mixed atomic configurations are given in tensor notation. These results are obtained by expanding in powers of (v/c^2) the equivalent operators for the Breit equation. An operator is obtained which has angular dependence unlike that of any operator appearing in the equivalent electron case. The particular case of interactions within configuration $l^n l'^m$ is discussed. (auth)

41363 ANTISYMMETRIZATION OF GEMINAL WAVE FUNCTIONS. III. CALCULATIONS OF THE DENSITY MATRIX AND ENERGY OF A THREE-ELECTRON ATOM. Peat, F. David (National Research Council of Canada, Ottawa). Phys. Rev., 173: 69-75(Sept. 5, 1968).

The conditions, which have been discussed in two previous papers, for the antisymmetrization of a geminal-sum wave function were applied, in a numerical example, to the calculation of the density matrix and energy of the three-electron ion Be^+. The consequences of imposing spin symmetry upon the wave function and the effects of relaxing the antisymmetrization procedure are both discussed. A ground-state energy of −14.3024 a.u., some 0.2% above the "experimental energy," is obtained, and the corresponding density matrix given. (auth)

41364 HYPERFINE STRUCTURE AND LIFETIMES OF THE $4^2P_{\frac{1}{2}}$ AND $5^2P_{\frac{1}{2}}$ STATES OF ^{39}K. Schmieder, Robert W.; Lurio, Allen; Happer, W. (Columbia Univ., New York. Phys. Rev., 173: 76-80(Sept. 5, 1968).

The hyperfine constants of the $4^2P_{\frac{1}{2}}$ and $5^2P_{\frac{1}{2}}$ states of ^{39}K were measured using the optical level-crossing method. The results are: $a(4^2P_{\frac{1}{2}}) = 6.0 \pm 0.1$ Mc/sec; $b(4^2P_{\frac{1}{2}}) = 2.9 \pm 0.2$ Mc/sec; $a(5^2P_{\frac{1}{2}}) = 1.95 \pm 0.05$ Mc/sec; $b(5^2P_{\frac{1}{2}}) = 0.92 \pm 0.1$ Mc/sec. These hfs constants are accurately proportional to the fine structure intervals to within 1%. These data, and the results from previous measurements on the $^2P_{\frac{1}{2}}$ states, yield values for the ratio $a(P_{\frac{1}{2}})/a(P_{\frac{1}{2}})$ in good agreement with measurements on other alkali atoms. The calculated quadrupole moment is $Q = (0.053 \pm 0.008) \times 10^{-24}$ cm², including Sternheimer corrections. The lifetimes of these states were determined to be: $\tau(4^2P_{\frac{1}{2}}) = 26.0 \pm 0.5$ nsec and $\tau(5^2P_{\frac{1}{2}}) = 140.8 \pm 1.0$ nsec. (auth)

41365 PERTURBATION–THEORETIC APPROACH TO ATOMS AND MOLECULES. Musher, Jeremy I.; Schulman, Jerome M. (Yeshiva Univ., New York). Phys. Rev., 173: 93-107(Sept. 5, 1968).

A general perturbation–theoretic procedure for obtaining accurate wave functions for atoms and molecules is developed in

detail for an arbitrary separable H_0, and the explicit equations satisfied by the various parts of the first- and second-order perturbed wave functions are given. It is shown how the solutions for the nth-order perturbed function can be found in terms of solutions to partial differential equations in only n + 1 variables for atoms, and in terms of solutions to sets of coupled equations in the same n + 1 variables for molecules. It turns out that for atoms the number of pair equations that need be solved to give Ψ_1 and the major part of Ψ_2 is roughly proportional to N, the number of electrons; while for molecules of no symmetry, with paired electrons, it is proportional to $N(N+2)/8$ as distinguished from the $N^2/4$ expected previously. This reduction in the number of necessary pairs may be of some practical use if the pair equations are integrated numerically. Various Hamiltonians are discussed, and an "exchangeless" Hamiltonian is introduced, which can serve to simplify the computations relative to the usual Hartree–Fock procedure, and might serve to increase the rate of convergence. Numerical calculations are performed for the helium-atom ground state in order to illustrate the procedure and to examine the rates of convergence of the expansions based on several different H_0's. Results differing from the exact result by $2 - 9 \times 10^{-4}$ are obtained for the different calculations through third order, and this error cannot be reduced by changing H_0. The angular expansion and the numerical integration technique used on the two-dimensional equations are sufficiently accurate that the third-order energy agrees to within 7×10^{-6} of Knight and Scherr's value. (auth)

41366 MAGNETIC HYPERFINE INTERACTION CONSTANTS AND ELECTRONIC g FACTORS FOR EIGHT ATOMIC STATES OF ^{103}Rh. Chan, Y. W.; Childs, W. J.; Goodman, L. S. (Argonne National Lab., Ill.). Phys. Rev., 173: 107-14(Sept. 5, 1968).

Electronic g factors and magnetic hyperfine interaction constants were measured for the eight lowest-lying atomic levels of ^{103}Rh. The data are analyzed in terms of available wave functions. (auth)

41367 CALCULATION OF RESONANCE BROADENING. Zaidi, Haider R. (Univ. of Tennessee, Knoxville). Phys. Rev., 173: 123-32(Sept. 5, 1968).

The line-shape function is expressed in terms of three boundary functions related to the two-particle Green's function. The transverse as well as the longitudinal interaction among atoms is considered, using the photon propagator approach. The broadening of one of the radiative states through the resonance interaction with the ground state is considered in detail. The contributions of multiple transfer of excitation and of two-body scattering are calculated separately. Several validity conditions are also obtained which clarify the approximations in the existing results. The velocity dependence of the width parameter is investigated in some detail; our results differ considerably from the existing results because we have included higher-order contributions. The extreme low-density region [where (collision width) ~ (natural width)] is also considered; the linewidth is found to be nonlinear in the number density. The additional contribution of the coupling between the radiative states is also calculated in a special case. (auth)

41368 CROSS SECTION FOR THE PHOTODETACHMENT OF ELECTRONS FROM I^-. Steiner, Bruce (National Bureau of Standards, Washington, D. C.). Phys. Rev., 173: 136-42(Sept. 5, 1968).

The cross section for photodetachment of I^- at 347 nm, 0.5 eV above threshold, was determined to be $(2.9 \pm 0.5) \times 10^{-17}$ cm^2. This value was obtained in a crossed-beam experiment by comparison with photodetachment from H^- at 993 nm, 0.5 eV above its threshold. The present determination permits placement of the previously determined relative-cross-section curve for the first electron volt above threshold on an absolute scale. The entire experimental curve is compared with the recent calculation of Robinson and Geltman. Although the shapes of the two curves are very similar, the new experimental cross section exceeds the calculation by nearly a factor of 2. (auth)

41369 CRITICAL ASSESSMENT OF THE POLARIZED-ORBITAL METHOD IN ATOMIC SCATTERING. Mittleman, Marvin H.; Peacher, Jerry L. (Univ. of California, Berkeley). Phys. Rev., 173: 160-4(Sept. 5, 1968).

The method of polarized orbitals used in calculating electron–atom scattering amplitudes has two obvious flaws: the wave function is discontinuous, and the method is not variationally based. These are corrected in a somewhat arbitrary manner, and it is found that the results then depend upon a parameter of the theory sufficiently strongly that there are serious doubts about the predictive nature of the theory. (auth)

41370 COUPLED-STATES METHOD FOR SCATTERING CALCULATIONS. Perkins, J. F. (Redstone Arsenal, Ala.). Phys. Rev., 173: 164-71(Sept. 5, 1968).

The eigenfunction-expansion method for calculating scattering of electrons and positrons from atoms has the very desirable property of providing phase-shift bounds, but is slowly convergent in some cases. Phase-shift bounds and improved convergence are combined in recently developed hybrid methods, but these are complicated to apply. An alternative method based on expansion in target states, some of which are chosen for best convergence rather than restricted to eigenstates, is proposed. The coupled equations are similar to those of the eigenfunction-expansion method and provide phase-shift bounds. The method was tested by calculation of S-wave positron–hydrogen scattering at energies of $k^2 = 0$, 0.04, 0.16, and 0.36. Target states used in the expansions (1s2p′ and 1s2p′3d′) were of the same functional form as eigenstates, except that orbital exponents were not fixed at $\frac{1}{2}$ and $\frac{1}{3}$. Calculated phase shifts as a function of orbital exponent value have a broad maximum for exponent values larger than those of eigenfunctions, and phase shifts are considerably larger than those calculated with eigenfunction expansions. (auth)

41371 ELECTRON CAPTURE INTO THE n = 3 STATES OF H BY FAST H^+ IMPACT ON N_2. Hughes, R. H.; Doughty, B. M.; Filippelli, A. R. (Univ. of Arkansas, Fayetteville). Phys. Rev., 173: 172-7(Sept. 5, 1968).

Electron capture into the 3s, 3p, and 3d states of hydrogen was measured for 10- to 35-keV proton impact on N_2. Polarization of the 3d → 2p and 3p → 2s radiations resulting from the collisions was also measured. The cross sections for the production of Balmer-alpha radiation were calculated from the 3s, 3p, and 3d cross sections and compared with those of previous investigations. The 3d cross section is about equal to the 3s cross section at 10 keV, but decreases monotonically as the energy is increased to 35 keV. (auth)

41372 POLARIZATION POTENTIAL IN LOW-ENERGY ELECTRON–H_2 SCATTERING. Lane, Neal F. (Rice Univ., Houston, Tex.); Henry, Ronald J. W. Phys. Rev., 173: 183-90 (Sept. 5, 1968).

An adiabatic polarization potential appropriate to low-energy electron–H_2 scattering was calculated by a variational approach. The total energy of the static electron–H_2 system is minimized with respect to the parameters $C_{\alpha\beta}$ in a trial function of the form $\psi_0(1,2)\Sigma_{\alpha,\beta}C_{\alpha\beta}(x_1 + x_2)^\alpha (z_1 + z_2)^\beta$, where $\psi_0(1,2)$ is Joy and Parr's one-center ground-state function. The subscripts 1 and 2 refer to the molecular electrons. The polarization potential is found to be well represented by $v_0^0(r) + v_2^2(r)P_2(\cos\theta)$, where θ specifies the position vector of the static electron with respect to the internuclear axis. The radial functions $v_0^0(r)$ and $v_2^2(r)$ were determined over a wide range in r. The polarization potentials are used in a calculation of rotational–excitation cross sections. Comparisons are made with results of other investigations. (auth)

41373 VARIATIONAL BOUNDS IN POSITRON–ATOM SCATTERING. Drachman, Richard J. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 173: 190-202(Sept. 5, 1968).

Dalgarno and Lynn's complete first-order adiabatic correlation function was previously applied to the problem of low-energy elastic positron scattering by hydrogen and helium atoms. This approach is now extended to yield rigorous lower bounds on the scattering phase shifts in the case of hydrogen and "quasi bounds" for helium. In addition, the positron annihilation rate in helium is reevaluated, and lower values are now found, with the enhancement factor over the Dirac rate varying between 1.5 and 1.8. Some comparisons are made between the present method and other recent work. (auth)

41374 UPPER AND LOWER BOUNDS ON s-WAVE ELECTRON–HYDROGEN SCATTERING. I. Madan, Rabinder N. (Univ. of California, Santa Barbara). Phys. Rev., 173: 214-21 (Sept. 5, 1968).

A uniform method of determining upper and lower bounds on phase shifts is presented for three-body problems in the case that two of the particles are identical, by taking s-wave triplet e^-–H scattering as a model. The method of evaluation of the upper bound involves replacing an effective optical potential by its separable lower bound in the integrodifferential equation, which is then solved numerically. At this state of the calculation an error of 20%, at the maximum, is reported. Variational methods for the improvement of this calculation and potentialities of this approach for the study of e^-–H scattering in the inelastic region are discussed. (auth)

41375 RESONANCE SCATTERING OF SLOW ELECTRONS FROM H_2 AND CO: ANGULAR DISTRIBUTIONS. Ehrhardt, H.; Langhans, L.; Linder, F.; Taylor, H. S. (Univ., Freiburg i. B.). Phys. Rev., 173: 222-30(Sept. 5, 1968).

Energy and angular dependences of the elastic and inelastic scattering of electrons from H_2 and CO were measured in the

energy range from 0.5 to 10 eV and for scattering angles ranging from 5 to 110°. The elastic cross sections are composed of potential and resonance scattering and therefore are difficult to interpret. The excitation of molecular vibrations, i.e., scattering into inelastic channels, contains predominant contributions from short-lived negative ion compound states. The qualitative agreement of the measured angular dependence with that predicted from pure resonant scattering considerations is shown to be able to fix certain symmetry quantum numbers of the molecular state. Moreover, characteristic and similar σ-, π-, Δ-... type angular dependences throughout the whole energy range of the molecular resonance (independent of the final vibrational state) are presented as a means of verifying the presence of a resonance, even when the short lifetime masks the usually characteristic resonant peaks. The half-width of the $CO^{-2}\pi$ state is about 0.4 eV, that for $H_2^{-2}\Sigma_u^+$ between 2 and 4 eV. Absolute total cross sections for the different inelastic channels are given. The resonances of N_2, CO, and H_2 are compared with the predictions of the single-particle-shape resonance model and their physical properties are discussed using the different potential energy terms at large distances between the additional electron and the molecule. Throughout, stress is laid on the importance of choosing the proper experiment (i.e., exit channel) when resonance study is desired. Predictably, in using angular dependence, certain channels hide and others exhibit the presence of the resonance. (auth)

41376 REACTIONS OF H^+ IN H_2 AND D^+ IN D_2: MOBILITIES OF HYDROGEN AND ALKALI IONS IN H_2 AND D_2 GASES. Miller, T. M.; Moseley, J. T.; Martin, D. W.; McDaniel, E. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 173: 115-23(Sept. 5, 1968).

Measurements of transport parameters of low-energy mass-identified ions in H_2 and D_2 gases were made in a drift-tube mass spectrometer at room temperatures. In addition, the variable drift distance of this apparatus was used to vary the residence time of the ions in the gases to determine ion-molecule reaction rates. The zero-field reduced mobilities of H^+ and H_3^+ in H_2 were found to be 15.7 ± 0.6 and 11.1 ± 0.5 cm^2/V sec, respectively. Those for D^+ and D_3^+ in D_2 were found to be 11.2 ± 0.5 and 8.0 ± 0.3 cm^2/V sec, respectively. The zero-field reduced mobilities for Li^+, Na^+, and K^+ ions in H_2 were measured to be 12.3 ± 0.6, 12.2 ± 0.6, and 12.8 ± 0.6 cm^2/V sec. The zero-field reduced mobilities for these same alkali ions in D_2 were measured to be 9.6 ± 0.5, 8.9 ± 0.4, and 9.4 ± 0.5 cm^2/V sec, respectively. The mobilities of H^+, H_3^+, Li^+, Na^+, and K^+ in H_2 were found to be related to the mobilities of D^+, D_3^+, Li^+, Na^+, and K^+ in D_2, respectively, by the appropriate ratios of the square roots of the reduced masses in each case, as predicted by Langevin's theory. However, the mobilities within either set of ions in a given gas did not follow the $M_r^{-1/2}$ reduced mass dependence. The three-body reaction rate coefficients for the reactions $H^+ + 2H_2 \rightarrow H_3^+ + H_2$ and $D^+ + 2D_2 \rightarrow D_3^+ + D_2$ were found to be (3.2 ± 0.3) and (3.0 ± 0.4) × 10^{-28} cm^6/sec, respectively, and were observed to be independent of E/N in the thermal range ($E/N < 28 \times 10^{-17}$ V cm^2) and independent of the gas pressure from 0.1 to 0.6 Torr. A classical calculation shows that the assumption of Langevin-type spiraling collisions between the ions and gas molecules does not yield collision times long engough to account for the large three-body rate coefficients measured. Finally, a few measurements of the radial diffusion coefficient for H_3^+ ions in H_2 were made, and they agree with those reported by Dutton et al. within the scatter in the data, but not with those reported by Skullerud. (auth)

41377 COMMENT ON APPROXIMATE MOLECULAR ORBITALS. III. THE $1s_\sigma$ AND $2p_\pi$ STATES OF HeH^{++}. Matcha, R. L. (Battelle Memorial Inst., Columbus, Ohio); Lyon, W. D.; Hirschfelder, J. O. Can. J. Phys., 46: 1647-8(July 15, 1968).

The results and conclusions of a recent paper by Cohen, McEachran, and McPhee concerning a perturbation calculation of the ground-state energy of HeH^{2+} are compared with those found in an earlier paper by Matcha, Lyon, and Hirschfelder, which treated the same problem using essentially identical variation–perturbation techniques with a more general trial function. (auth) (Canada)

41378 CROSS SECTION FOR THE PHOTOIONIZATION OF LITHIUM. Gezalov, Kh. B.; Ivanova, A. V. (Inst. of Chemical Physics, Moscow). Teplofiz. Vys. Temp., 6: 416-20(May-June 1968). (In Russian).

The photoionization cross section of lithium was calculated by the self-congruent field method, with consideration of exchange, for the ground and first ten excited states in the wavelength interval from 300 to 22,300 Å. The results for the ground state agree satisfactorily with the experimental data in the area from 2300 to 1150 Å and with the results calculated previously by this method and by the quantum defect method in the spectral range from 2300 to 1800 Å. The calculation for the excited states of lithium was done for the first time. (tr-auth)

41379 CHANNELING IN CRYSTALS. Brandt, Werner. Sci. Amer., 218: No. 3, 91-8(Mar. 1968).

The recent discovery that a beam of charged particles can pass through a crystal lattice in certain directions with surprising ease is examined for its theoretical and practical implications. (auth)

41380 APPLICATION OF THE COULOMB GREEN'S FUNCTION TO THE COMPUTATION OF ATOMIC PROPERTIES ON THE BASIS OF THE PERTURBATION THEORY. Khristenko, S. V.; Vetchinkin, S. I. Dokl. Akad. Nauk SSSR, 180: 655-8(May 21, 1968). (In Russian).

The perturbation theory has been successfully applied to the investigation of the electron shells of atoms. The difficulties arising from the summing on the basis of the intermediate states of hydrogen atoms may be eliminated by making use of Green's function. Thus, by making use of the Green's function of Schrodinger's equation, all the states of the discrete spectrum may be summed. Use of this method involving Coulomb Green's function in computing atomic properties was examined. The probability of optical transitions was investigated, using the nondiagonal matrix element of the dipole moment for the $1^1S_0 - 2^1P_1$ transition as an example. The Green's function may also be used to calculate corrections in the wave function. (TTT)

41381 VIRTUAL PROTON COMPTON EFFECT ON THE WIDE ANGLE BREMSSTRAHLUNG AND POLARIZATION PHENOMENA. Greco, M. (CNEN, Frascati, Italy); Tenore, A.; Verganelakis. Phys. Lett., 27B: 317-20(Aug. 5, 1968).

It is shown that the virtual proton Compton contribution on the wide angle bremsstrahlung may change appreciably the QED predictions, when the intermediate lepton is far off its mass shell. Polarization measurements are encouraged as providing a new source of information about virtual proton Compton effect. (auth)

Cosmic Radiation

Refer also to abstracts 40107, 40365, 41210, 41265, and 41824.

41382 (N-68-22849) STUDY OF RADIATION HAZARDS TO MAN ON EXTENDED MISSIONS. Curtis, S. B.; Wilkinson, M. C. (Boeing Co., Seattle, Wash.). May 1968. Contract NASw-1362. 89p. (NASA-CR-1037). CFSTI.

An attempt is made to identify the particle types and energies important in the evaluation of the radiation hazard on long manned missions outside the magnetosphere. Important areas where information is presently lacking are identified. Spectra of the various components of the galactic cosmic radiation have been compiled from experimental data gathered during the period of minimum solar activity. These spectra, as well as typical solar-particle spectra, have been used to determine depth–dose curves and differential particle and dose spectra behind typical shielding thicknesses. From this analysis, the important energies for various thicknesses and various spectra have been determined. In general, low-energy particles (below 100 MeV) appear to be most important at the dose point in solar-particle events. From the biological standpoint, very low-energy particles are important only for very steep spectra. The high-energy heavy component of the galactic cosmic rays is of considerable importance for thin shielding and it appears that low-energy heavy particles may continue to be important at thicker shielding, although secondary production data are not available for a thorough analysis. (auth) (STAR)

41383 MAXIMUM-LIKELIHOOD DETERMINATION OF THE DENSITY SPECTRUM PARAMETERS OF THE EXTENSIVE AIR SHOWERS. Betev, B. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 103-9(1968). (In Russian).

The problem of determination α and γ parameters of the density spectrum of extensive air showers is solved by observing frequences registered in a specified point with a k-channel ($k \gtrsim 3$) experimental arrangement. The problem is solved by the method of maximum-likelihood, provided the differential density spectrum is of the kind $\alpha x^{-\gamma-1}\,dx$, α and γ being the unknown parameters and x the shower particle density. (auth)

41384 MAGNETIC CUT-OFF OF EXTRAGALACTIC PROTONS IN THE GALACTIC DISK. Thielheim, K. O.; Langhoff, W. (Univ., Kiel). Nature (London), 219: 355-7(July 27, 1968).

It is stated that there is some uncertainty about the exact position of the first knee, and concerning the existence of a second knee, in the integral energy spectrum of cosmic particle radiation. If these exist, they may be consequences of the transition from galactic to extragalactic contributions caused by the presence of a large scale ordered magnetic field in the galactic disk. When studying the magnetic cutoff, the combined distribution function of

magnetic rigidity and direction may be considered instead of angular distribution. The expectation that the observed distribution function will contain galactic as well as extragalactic contributions is discussed. Cutoff rigidities were calculated for extragalactic particles. A model for the large-scale ordered magnetic field of the galactic disk, as a basis for the calculation of high energy cosmic-ray particle trajectories, is discussed. Cutoff energies for extragalactic protons reaching the Earth from various directions are shown graphically. It is considered that the results are consistent with the fact that no anisotropy of total cosmic particle radiation has so far been found in the energy region considered. (UK)

41385 EVIDENCE FOR THE EXISTENCE OF COSMIC-RAY PARTICLES WITH ENERGY $\geq 5 \times 10^{19}$ eV. Andrews, D.; Evans, A. C.; Reid, R. J. O.; Tennent, R. M.; Watson, A. A.; Wilson, J. G. (Univ. of Leeds, Eng.). Nature (London), 219: 343-6(July 27, 1968).

The analysis of an extremely energetic air shower produced by a primary cosmic-ray particle of energy $\geq 5 \times 10^{19}$ eV is described. The flux of particles of this energy is shown to be greater than expected under certain assumptions concerning universal black body radiation and the location of cosmic-ray sources. The observation also provides some evidence that the primary particles in this energy region are protons. (auth) (UK)

41386 THE FORBUSH EFFECT. Ducrocq, Albert. Sci. Avenir, No. 252, 118-23(Feb. 1968). (In French).

The Sun controls cosmic radiation about the Earth in much the same way as an amplifier element operates. A new model of the solar system has been proposed which demonstrates that "extra-terrestrial intelligence" is not the origin of certain emissions, but that they are the product of a natural origin. The structure of the solar wind is described, and it is shown that cosmic rays may be deflected by the magnetic field of the Sun. Determination of data from interplanetary vehicles indicates that the Forbusch effect is tenable. The measurement of these data is not simple; however, attention is drawn to the Pioneer program of the U. S. for detection of weak magnetic fields. Various radioisotope methods on the surface of the Earth, using isotopes produced in the upper atmosphere by cosmic rays, are suggested for study of the problem. The short life of ^{3}H makes it impractical, but possibly results with ^{14}C could be used. Lunar studies will also be of value. (BBB)

41387 DISTRIBUTION CHANGES OF THE MESON AND NUCLEON COMPONENTS OF COSMIC RAYS AND SOLAR ACTIVITY. Stensland, Bengt. Abstracts of Uppsala Dissertations in Sience. Uppsala, Univ. of Uppsala, 1968. 19p.

Thesis.

A review is given on 4 published papers on the following subjects: Directional distribution of the cosmic-ray meson component and solar activity, cosmic-ray anisotropy associated with storm sudden commencements, cosmic-ray perturbations associated with solar activity, and perturbation of the neutron component of cosmic rays during the initial phase of Forbush decreases. (Sweden)

41388 NATURE OF COSMIC RAYS UNDERGROUND. Ashton, F.; Edwards, H. J.; Kelly, G. N.; Wolfendale, A. W. (Univ. of Durham, Eng.). Phys. Rev. Lett., 21: 303-4(July 29, 1968).

The suggestion by Callan and Glashow that there is a new component of cosmic rays comprising stable massive charged particles is examined with respect to present experimental evidence. Direct analysis of particle masses at sea level, the angular distribution of low-energy muons, and the energies of energetic muons at great depths underground all point to the likely non-existence of these particles, at least to the suggested extent of 10^{-3} of the normal primary component. (auth)

41389 COSMIC-RAY LIFETIME AND HIGH-ENERGY γ RAYS FROM THE GALAXY. Dilworth, C.; Maraschi, L.; Perola, G. C. (Univ., Milan). Nuovo Cim., 56B: 334-7(Aug. 1, 1968).

It is pointed out that the mean life of cosmic particles in the galaxy can, in principle, be derived from a knowledge of the flux of those electrons and gamma rays which arise from the decay of charged and neutral pions produced in nuclear collisions of cosmic rays with interstellar matter. Two models are considered: the disc model in which the confinement region coincides with the optical disc of the galaxy and the disc + halo model in which the confinement region is roughly a sphere with radius 15 kiloparsec, including the galactic disc and halo; then it is assumed that the total amount of matter in the halo does not exceed that of the disc. The lifetime of the charged cosmic particles in the galaxy is plotted against the average flux of high-energy gamma rays from the galactic disc for the various models. (J.F.P.)

41390 SHORT PERIOD FLUCTUATIONS IN COSMIC RAY INTENSITY AND INTERPLANETARY FIELD. Patel, V. L. (Univ. of Denver). Planet. Space Sci., 16: 818-20(June 1968).

A possible mechanism is suggested which could explain how fluctuations in the interplanetary magnetic field can cause similar fluctuations in the cutoff rigidities of cosmic rays. (UK)

41391 PROMINENT ELECTROMAGNETIC CASCADES IN EXTENSIVE AIR SHOWERS. Thielheim, K. O.; Schlegel, E. K.; Beiersdorf, R. (Univ., Kiel). J. Geophys. Res., 73: 5012-14 (Aug. 1, 1968).

Significant maxima of charged-particle density in the core region of extensive air showers have been observed by various authors with the help of neon hodoscopes and large spark chamber arrangements. These maxima have been interpreted as single electromagnetic cascades and have been related to properties of high-energy secondary mesons in nuclear interactions and to the chemical composition of primary radiation. Results of Monte Carlo calculations on these suspected correlations are presented. (W.D.M.)

41392 EXTENSIVE AIR SHOWERS AT 5200 METRES ABOVE SEA LEVEL AND SEARCH FOR HIGH ENERGY PRIMARY GAMMA RAYS. Clark, G.; Escobar, I.; Murakami, K.; Suga, K. (Univ. Mayor de San Andres, La Paz, Bolivia). Contract AF49(638)-922. Pontif. Acad. Sci. Scr. Varia, No. 25, 29-60(1963).

The preliminary results obtained during the first six months of the operation of the Bolivian Air Shower Joint Experiment (BASJE) at Chacaltaya are reported. The report is presented in two parts. Part I describes the chief characteristics of EAS's observed at 5200 m above sea level. The main results of this study are: a) the observed showers having sizes in the range $\sim 10^5$ to $\sim 10^6$ are near their maximum development; b) the fluctuations in the number of muons in the observed showers are only one third of that observed at sea level; c) that lateral distribution of the observed showers, follows N.K.G. function with best "s" value slightly less than unity; d) there exists an indication of a "knee" in the size spectrum of the showers in the range 2×10^5 to 5×10^5. Part II mainly outlines the approach for the search for high-energy primary gamma rays. Results, pertaining to this study, indicate that there exist a group of showers having an extraordinarily small proportion of muons. The ratio of the frequency of this group of showers to that of ordinary showers is $\sim 3 \times 10^{-4}$ for energies above 10^{15} eV. It is suggested that this group of showers may have as their parent high-energy primary gamma rays although the possibility of this group of showers having been produced by an extreme fluctuation of a few neutral pions cannot be ruled out. Further, there is some indication of a possible excess of the muonless showers coming from the plane of the Galaxy, though this result has not been established with high enough statistical precision. (auth)

41393 DOSIMETRIC MEASUREMENTS ON BOARD THE COSMOS 110 SATELLITE. Shavrin, P. I.; Tel'tsov, M. V.; Senchuro, I. N.; Shumshurov, V. I.; Kochnov, V. T. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 5, 106-8(Sept.-Oct. 1967). (In Russian).

An RZ-AM radiometer with Geiger counters and highly sensitive IK-4 ionization chambers were used in Cosmos-110 dosimetric studies. Data obtained during Cosmos-110 flight from Feb. 22 till March 16, 1966 are tabulated. The results from various detectors indicated that the mean specific ionization recorded by the transducers in the internal block are four times higher than the ionization of relativistic particles and corresponds to protons with a mean energy of less than 100 MeV; the particle flux recorded by the external SI-3 BG counter was one order higher than the flux recorded by the internal counter. (R.V.J.)

41394 ENERGY SPECTRUM OF COSMIC-RAY EXTENSIVE AIR SHOWERS. Jatczak, Jerzy (Univ., Lodz, Poland). Nukleonika, 13: 621-33(1968). (In Polish).

A value was found for exponent $\Gamma = 2.11 \pm 0.02$ for showers with total number of particles $4 \times 10^6 < N < 2 \times 10^7$. During calculation of Γ it was accepted that the dependence of total number N on energy E of primary particles is given by the function: $N = DE^{1.14}$. (auth)

41395 ON THE VARIATIONS OF THE MEAN RECORDED MULTIPLICITY IN THE SUPER NEUTRON MONITOR 9-NM-64 AT OULU, FINLAND, FOR THE PERIOD NOVEMBER 5, 1965 TO APRIL 30, 1967. Niemi, S. (Univ. of Oulu, Finland). Can. J. Phys., 46: 1645-6(July 15, 1968).

An 18-month measurement of the mean recorded multiplicity $\overline{m}$ in a cosmic-ray super neutron monitor 9-NM-64 was performed. The main principles of the calculation of $\overline{m}$ are presented. The variations of the intensity recorded by the cosmic-ray neutron monitor are, percentage wise, found to be smaller with the multiplicity effect than without it. The time variations of the standard deviation correction factor $\sqrt{(\overline{m^2}/\overline{m}^2)}$ seem to be negligible. (auth) (Canada)

Direct Energy Conversion

Refer also to abstracts 40322–40324.

41396 (AD-668263) DIRECT CONVERSION OF VARIOUS FORMS OF ENERGY INTO ELECTRIC AND MECHANICAL POWER. Alekseev, G. N. Translated for Foreign Technology Div., Wright-Patterson AFB, Ohio, from Neposredstvennoe Prevrashchenie Razlichnykh vidov Energii v Elektricheskuyu Mekhanicheskuyu, Moscow/Leningrad, 1963. 270p. (FTD-MT-64-355). CFSTI.

The following are included: direct conversion of chemical energy to electrical energy (theory of fuel cells, fuel cells with solid fuel, fuel cells with gaseous fuel, combined (solid–gas) fuel cells, fuel cells with liquid fuel, oxidizing reducing cells, possibilities of application of fuel cells); direct transformation of thermal energy into electrical and mechanical energy (thermoelectric generators, vacuum thermionic emission electric generators, gas-filled thermionic emission electric generators, certain general questions for thermionic electric generators, information on magnetohydrodynamics, magnetohydrodynamic electric generators, electrorocket motors); direct transformation of nuclear energy into electrical and mechanical energy (radioisotope electric generators, nuclear radioisotope motors, nuclear reactor electric generators, nuclear reactor motors, thermonuclear electric generators, thermonuclear motors); direct transformation of solar energy into electrical and mechanical energy (solar electric generators, solar sail, photon rocket motor). (USGRDR)

41397 (AD-668454) BOUNDARY PHENOMENA IN MHD GENERATORS. Eustis, R. H.; Mitchner, M.; Kruger, C. H. (Stanford Univ., Calif. Plasma Gasdynamics Lab.). Feb. 15, 1968. Contract AF49(638)-1695. 20p. (AFOSR-68-0859). CFSTI.

The investigations included in this research are as follows: experiments on turbulent Hartmann flow in plasmas; turbulence suppression in magnetohydrodynamic flows; nonuniform electrical conduction in magnetohydrodynamic channels; electrostatic probe theory and application in a high-temperature, collision-dominated, potassium-seeded argon plasma; electron transport coefficients for two-temperature plasmas; necessary conditions for the validity of the two-temperature plasma model; experimental electrode current distributions in MHD channels; the influence of boundary layers on spectroscopic temperature measurements in MHD channels; discharge characteristics in a seeded plasma flow. (auth) (USGRDR)

41398 (AE-324) THEORETICAL INVESTIGATION OF AN ELECTROGASDYNAMIC GENERATOR. Palmgren, Soeren (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1968. 35p. Dep.

In an electrogasdynamic generator a portion of the enthalpy of a high velocity gas flow is converted directly into electrical energy through forcing unipolar charge carriers against an electric field. In a first attempt we try to describe this process by use of a one-dimensional mathematical model with an adiabatic flow. An exact analytic equation is derived for this case. Assuming the interaction between the charge carriers and the gas to be a perturbation of the first order this equation can be solved analytically. The zero order perturbation, i.e., constant thermodynamic state of the flow, agrees with previous analyses. It is found that this is an adequate approximation for the linear model. A complete analysis of a cylindrical EGD generator must however take into account the radial electric field due to the space charge and the losses due to radial diffusion and mobility. A tentative investigation of a three dimensional axially symmetric model was therefore made, including a survey and criticism of some earlier analyses. (auth)

41399 (GA-8900) LONG TERM OPERATIONS OF IN-PILE THERMIONIC CONVERTERS. Holland, J. W.; Yates, M. K.; Schwarzer, D. E.; Kay, J. (Gulf General Atomic, Inc., San Diego, Calif.). June 10, 1968. Contracts AT(04-3)-167; NAS-3-80504. 22p. (CONF-680508-6). Dep. CFSTI.

From 2nd International Conference on Thermionic Electrical Power Generation, Stresa, Italy.

I. Ten cylindrical geometry converters with series designation Mark VI were life tested in-pile for a total of 20,034 hours, an average life of 2003 hours, and an average electrode power density of 7.2 W/cm^2. The longest test to date ran for 5369 hours at an average electrode power density of 10 W/cm^2. That test designated as IC-15 was fueled with UO_2 and achieved a burnup of 2×10^{20} fission/cm^3. II. Out-of-pile models of the Mark VI converters were life tested for a total of 51,542 hours, an average life of 6443 hours and an average power density of 7.9 W/cm^2. The longest test to date ran 10,406 hours at an average electrode power density of 8.6 W/cm^2. Both unfueled and fueled versions were tested. (auth)

41400 (N-68-16191) HANDBOOK OF SPACE ENVIRONMENTAL EFFECTS ON SOLAR CELL POWER SYSTEMS. Cooley, William C.; Barrett, Matthew J. (Exotech, Inc., Alexandria, Va.). Jan. 1968. Contract NASw-1345. 243p. (NASA-CR-92675; TR-025). CFSTI.

In the design of solar cell power systems for earth satellites or interplanetary spacecraft, consideration should be given to bombardment by energetic electrons, protons, and micrometeoroids during the proposed mission, the type of solar cells, the type and thickness of shielding material, the operating voltage, and the expected operating temperature range. This handbook provides a review of research data and analytical methods which can be used to design radiation-resistant silicon solar cell power systems for earth satellites which have orbits passing through the magnetosphere and for spacecraft exposed to solar flares and micrometeoroids. (STAR)

41401 (N-68-21597) THERMIONIC CONVERTER AND GENERATOR TESTS. Rouklove, P. (Jet Propulsion Lab., Pasadena, Calif.). Mar. 1, 1968. Contract NAS7-100. 15p. (NASA-CR-94154; JPL-TR-32-1244). CFSTI.

The results of tests of approximately 40 advanced-technology thermionic converters (all of planar geometry) and of 2 thermionic generators are presented, which were made to determine power output, maximum life, efficiency, and ability to withstand environmental stresses. Electron bombardment was used to simulate solar heating. In support of the converter and generator development ancillary experiments were performed to investigate (1) the reaction of alumina with molybdenum at high temperatures, (2) the accuracy of temperature measurements with different types of hohlraums with various L/D ratios, (3) the effects on the performance of a converter when enclosed in a generator configuration, and (4) the relationship between the shape of the emitter and that of the filaments used in the electron bombardment. Improved test equipment enabled simpler operation and, also, provided greater accuracy in diagnostic measurements. It was demonstrated that the units assembled have increased power and long-term life and can stand the stresses of the Atlas/Agena launch environment. (auth) (STAR)

41402 (N-68-21766) ELECTRICAL PERFORMANCE OF A RHENIUM–NIOBIUM CYLINDRICAL THERMIONIC CONVERTER. Williams, Richard M.; Bifano, William J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1968. 23p. (NASA-TN-D-4533). CFSTI.

The electrical performance of a cylindrical rhenium–niobium thermionic converter was measured by a pulse technique for the following temperatures: emitter, 1873 to 2073°K; collector, 850 to 1050°K; and cesium reservoir, 590 to 670°K. The peak output power densities at 1873, 1973, and 2073°K were 7.0, 9.4, and 11.4 W/cm^2 at 0.4, 0.5, and 0.6 V, respectively. The corresponding collector temperatures were about 900, 940, and 950°K, and the cesium-reservoir temperatures were 595, 606, and 611°K. The Rason–Warner correlation was used to estimate a 5.0 ± 0.1 V work function for the vapor-deposited rhenium emitter. (auth) (STAR)

41403 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC ELECTRIC GENERATORS. Chapman, Alan George (to Associated Electrical Industries Ltd.). British Patent 1,116,866. June 12, 1968. Filed Dec. 7, 1964.

The magnetohydrodynamic electric generator described includes a gas duct so formed that it can be subjected in use to a transverse magnetic field. Each of at least two opposed electrode walls of the duct is in the form of a panel separable from the other walls. Liquid-cooled metal tubes line the inner surface of the wall and extend into inlet and outlet headers. (M.H.R.)

41404 IMPROVEMENTS IN AND RELATING TO THERMAL POWER PLANTS. Crampton, Felix Jeremy Philip; Wilkinson, Terence Sidwell (to Conch International Methane Ltd.). British Patent 1,118,041. June 26, 1968. Filed July 7, 1964.

A thermal power plant is described incorporating an MHD generator, exhaust gases from which are used as a source of heat for a second thermal power cycle. Liquefied natural gas is used for cooling the coils producing the magnetic field of the MHD generator and is then used as a fuel for the MHD generator. The liquefied natural gas may be used directly as the coolant for the magnet coils or an intermediary fluid may be used. (M.H.R.)

41405 MAGNETOHYDRODYNAMIC GENERATION OF ELECTRICAL ENERGY. (to United Aircraft Corp.). British Patent 1,121,792. July 31, 1968. Priority date Oct. 7, 1964, United States.

An MHD generator of electrical energy is described, which includes as a source of high-velocity high-temperature ionized gases, a solid fuel grain homogeneously seeded with a predetermined amount of at least one component possessing a low ion-

ization potential. The fuel grain is incapable of self-sustained combustion and the components of it are selected from the group consisting of alkali metals and compounds of alkali metals. (M.H.R.)

41406 ELECTRIC POWER GENERATING SYSTEM. (to Atomic Energy of Canada Ltd.). British Patent 1,121,882. July 31, 1968. Priority date Feb. 19, 1965, United States.

A system is described for generating electric power including a nuclear reactor and an MHD generator employing an alkali metal in vapor form as working fluid. The generator is located adjacent the reactor with the working fluid exposed to gamma radiation from the reactor to raise the degree of ionization of said fluid above its thermal equilibrium value. (M.H.R.)

41407 ELECTRICAL FIELD IN A RECTANGULAR MHD CHANNEL WITH SEMI-INFINITE ELECTRODES. Ignatenko, M. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 80-4 (Jan.-Mar. 1968). (In Russian).

The electric fields in MHD channels of rectangular cross section are found. Two walls of channels are semi-infinite electrodes and the other two, perpendicular to the direction of the external magnetic field, are insulated. The conducting liquid is assumed to be viscous and noncompressible. The solution of the problem is obtained by the Viner–Hopf method. (tr-auth)

41408 THE INFLUENCE OF NON-CONDUCTING PARTITION ON THE CHARACTERISTICS OF AN MHD CONVERTER. Lavrent'ev, I. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 27-32(Jan.-Mar. 1968). (In Russian).

The integral resistance was found for the electric current of plane channels filled with a conducting medium, having two semi-infinite electrodes, insulating walls, and one nonconducting partition of finite length, which was introduced into the channel before and behind the electrodes and symmetrical with respect to the latter. It was shown that the value of the resistance of the channel with increase of the length of the partition approached the corresponding value in the case of semi-infinite partitions sufficiently slowly (at $(\mu/\delta > 2$ as $[(12 \ln 2/\pi) + (4\mu/\delta)]^{-1}$, where μ is the length of the partition and δ is the half-width of the channel. (tr-auth)

41409 BOUNDARY LAYER AT THE ELECTRODE AND ITS INFLUENCE ON THE EFFECTIVITY OF ENERGY CONVERSION IN MHD CHANNEL. Apollonskii, S. M.; Koskin, Yu. P. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 33-40(Jan.-Mar. 1968). (In Russian).

The pre-electrode magnetogasdynamic boundary layer in channels of MHD converters was examined for two cases of flow in the core of the flow: T_∞ = const. and u_∞ = const. The thermophysical properties of the working substance were considered variable and dependent on the temperature. The case u_∞ = constant was considered for the first time and equations for the case T_∞ = const. were constructed in a comparatively wide temperature range. The calculation results on the ETSVM were applied to the determination of the pre-electrode potential drop. Data on the change of the friction stress and the Nusselt number were obtained simultaneously as a function of the conditions at the electrode and in the center of the current. (tr-auth)

41410 THE INTERACTION OF THE BOUNDARY LAYER ON THE COLD ELECTRODE WITH THE BASIC FLOW IN THE MHD CONVERTER. Yuferev, V. S. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 41-7(Jan.-Mar. 1968). (In Russian).

Equations of the plane laminar boundary layer and of the external one-dimensional flow were integrated jointly by the finite difference method for channels expanding by a linear law. It was assumed that the electrode was continuous and that the Reynolds number and Hall parameter were small. The effect of the boundary layer on the characteristics of the MHD generator is shown for different Hartmann number at the initial cross section of the channel. (tr-auth)

41411 MAGNETOHYDRODYNAMIC GENERATOR USING A LIQUID METAL WORKING FLUID. (to General Motors Corp.). British Patent 1,123,249. Aug. 14, 1968. Priority date July 25, 1966, United States.

An MHD generator system is described using a liquid-metal working fluid. The generator comprises a working fluid duct containing electrodes associated with a magnetic field, a feed mechanism for injecting a succession of liquid slugs into the duct, and an injector device for propelling the liquid slugs through the magnetic field at a high velocity. (M.H.R.)

41412 THERMIONIC CONVERTER BURNER ELEMENT. Janner, Karl (to Siemens Aktiengellschaft). U. S. Patent 3,393,329. July 16, 1968. Priority date Mar. 11, 1964, Germany.

The converter burner element described, for directly converting thermal energy from nuclear fission into electrical energy, comprises an elongated core of nuclear fuel, a plurality of serially connected thermionic diodes coaxially aligned on said core, said diodes having elongated cathodes and anodes extending in the flow direction of a plasma therebetween, the cathodes and anodes having cross sections varying at a constant rate inversely relative to one another, in said flow direction. (Offic. Gaz.)

41413 THERMIONIC CONVERTER WITH CURRENT AUGMENTED BY SELF-INDUCED MAGNETIC FIELD. Vary, Alex (to National Aeronautics and Space Administration). U. S. Patent 3,393,330. July 16, 1968. Filed June 24, 1965.

This converter has an electron-emitting electrode and a collector electrode disposed in spaced relationship in an envelope with a load being connected between the electrodes. The collector electrode comprises a pair of comb-like elements having intermeshed segments defining alternately narrow and wide spaces. Electrons reaching the collector flow in opposite directions in adjacent segments to produce a magnetic field which aids electron flow from emitter to collector. (Offic. Gaz.)

Fluid Physics

41414 HYDRODYNAMIC EQUATIONS UNDER NONLOCAL THERMODYNAMIC EQUILIBRIUM (KINETIC THEORY OF MULTICOMPONENTS GAS MIXTURE WITH RADIATION EFFECTS). Wu, Shi Tsan. Boulder, Colo., Univ. of Colorado, 1967. 114p. Thesis.

Attention is directed to some unsatisfactory features of macroscopic equations for the problem of mixture of gases. The main defects are in the region where the non-local-thermodynamic equilibrium (non-LTE) conditions prevail. In this study, an effort has been made to derive a set of macroscopic equations through the macroscopic description of Boltzmann's equation under the conditions of non-LTE. The densities, mean-flow velocities, specific energies, stress tensors, and heat-flow vectors of individual components are considered to be fundamental quantities in this description. To achieve a determined set of macroscopic equations, the component-velocity distribution function is approximated by means of a polynomial expansion with respect to the local thermodynamic variables; namely, with reference to the center-of-mass system. The component velocity distribution functions are then expressed as the product of the distribution functions for the center-of-mass system and the corrections depending on the differences of the temperature and mean-flow velocity of the components with respect to the center-of-mass system. These reduce to a Maxwellian distribution function of the component under the condition of LTE. The resulting equations which are obtained in this study reduce to the Euler's equation where the space gradient of the macroscopic quantities and the effects of cross-collision due to non-LTE are neglected. To the first order of the space gradients of macroscopic quantities, the stresses, heat flow, and diffusional velocity can be expressed in terms of the thermodynamic variables, with certain correction due to non-LTE. These quantities are equivalent to the type of the Chapman-Enskog theory of material constants and to the set of the Navier–Stokes equations, except that the present derivation includes the correction terms due to the effects of non-LTE. Collisional terms in the transfer equations are treated in two parts: (a) Elastic collisions: the terms have been evaluated exactly in terms of certain integrals depending on the type of interactions, and (b) Non-elastic collisions: the terms have been estimated in accordance with the mechanism of the creations and annihilations of the particles in the course of the non-elastic collisions. For the latter the collisional and radiative processes proposed by Bates et al., are chosen in this study; and the radiation problem is thus brought into the flow problem in a precise manner, to the order of the above approximation. In order to solve the radiative transfer problems, an appropriate source function has been derived; and the range of the validity of these equations is discussed in some detail. (Diss. Abstr.)

41415 FARADAY ROTATION OF ALFVEN WAVES IN LIQUID SODIUM. Druyvesteyn, W. F.; Greebe, C. A. A. J.; Smets, A. J.; Ruyg, R. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 27A: 301-2(July 15, 1968).

The observation of Faraday rotation of Alfvén waves in liquid sodium is reported: quantitative agreement with theoretical expectations is found. Measurements of this rotation yield information similar to that found from Hall effect measurements. (auth)

41416 ENERGY-TRANSPORT VELOCITY IN LOSSY MOVING FLUIDS. Sugai, Iwao (Communications and Systems, Inc., Falls Church, Va.). Proc. IEEE (Inst. Elec. Electron. Eng.), 56: 1133-4(June 1968).

The treatment of magnetohydrodynamics problems by Panofsky and Phillips has been extended from infinite to finite conductivity

of the fluid, and the energy-transport velocity of the induced electromagnetic wave in this fluid has been derived. (auth)

41417 BOUNDARY CONDITIONS AND EMF CALCULATIONS FOR MAGNETOHYDRODYNAMIC FLOW IN INFINITE CYLINDRICAL CONFIGURATIONS. Hughes, William F. (Carnegie-Mellon Univ., Pittsburgh). Proc. IEEE (Inst. Elec. Electron. Eng.), 56: 1132-3(June 1968).

In magnetohydrodynamics, infinite cylindrical configurations with a radial magnetic field cannot generally be used to model rectangular configurations. Consideration must be given to the necessary variations in the axial magnetic flux in order to create the radial magnetic field. (auth)

41418 POTENTIAL DISTRIBUTION RESULTING FROM FLOW ACROSS A MAGNETIC FIELD PROJECTING FROM A PLANE WALL. Baker, Roger C. (Cambridge Univ., Eng.). J. Fluid Mech., 33: 73-86(July 1968).

When a fluid of low-conductivity flows parallel to a plane wall from behind which projects a magnetic field an electric potential field is established throughout the fluid. In this paper the potential field is obtained explicitly in terms of the velocity field when the latter is unidirectional and depends only on the coordinate normal to the wall. Experiments with a variety of velocity profiles are described, and the agreement with the theory is satisfactory. The effect of slow variation of the profiles in the direction of the flow is considered, and is shown to be unimportant under the conditions of the experiments. (auth) (UK)

41419 STEADY ELECTRICALLY DRIVEN FLOWS. Waechter, R. T. (Flinders Univ., Bedford Park, Australia). Proc. Cambridge Phil. Soc., 64: 871-94(July 1968).

Certain simple steady electrically driven flows under transverse applied magnetic fields, for which exact solutions are available, are considered. Electric potentials are prescribed on fixed perfectly conducting electrodes, the resulting Lorentz force $j \times B_0$ giving rise to a velocity field in the fluid. It is assumed that the magnetic Reynolds number of the flow is small ($R_m \ll 1$), so that the induced magnetic field may be neglected. In particular, the simplest flat plate configuration, which is correctly posed as a two-part mixed boundary value problem of the Wiener–Hopf type is examined in detail. At large Hartmann number the fluid vorticity and the current flow transverse to the applied magnetic field are suppressed. Thin current transition layers, which emanate from an electrode edge and are aligned with the applied magnetic field, provide a smooth transition from one region of almost constant current to another. The thickness of these layers is found to be of the same order as the thickness of certain velocity transition layers occurring in other situations in magnetohydrodynamics. (auth) (UK)

41420 MAGNETOHYDRODYNAMIC FLOW THROUGH A RECTANGULAR DUCT DUE TO PERIODIC PRESSURE GRADIENT. Mandal, K. K. (Indian Inst. of Tech., Kharagpur). Appl. Sci. Res. (The Hague), 19: 97-110(June 1968).

The flow of an incompressible, viscous, electrically conducting fluid in a long channel of rectangular cross section due to a periodic pressure gradient, in the presence of a uniform transverse magnetic field is investigated. Exact solutions are obtained and asymptotic forms valid for large Hartmann numbers are discussed. (auth)

41421 MAGNETO-FLUID DYNAMIC PIPE FLOW. Maxworthy, T. (Univ. of Southern California, Los Angeles). pp 243-57 of Proceedings of the 1968 Heat Transfer and Fluid Mechanics Institute held at the University of Washington, Seattle, June 17–18, 1968. Emery, Ashley F.; Depew, Creighton A. (eds.). Stanford, Calif., Stanford University Press, 1968.

See CONF-680615.

A liquid sodium tunnel was designed and built to study aligned fields, magnetofluiddynamic (MFD) flows. Its major features and the nature of the flow in the test section are described. In particular, it is found that an exit disturbance, created as the liquid conductor leaves the region of magnetic field, can propagate into the test section and distort the uniform flow there. However, only under the most adverse conditions, i.e., very high magnetic fields and low flow velocities, does this impair the usefulness of the tunnel as a device for the accurate measurement of MFD flows. (auth)

41422 EXPERIMENTAL OBSERVATION OF THE ELECTROMOTIVE FORCE ALONGSIDE OF AN EXTERNAL MAGNETIC FIELD INDUCED BY THE FLOW OF LIQUID METAL (α EFFECT). Shteenbek, M.; Kirko, I. M.; Gailitis, A.; Klyavinya, A. P.; Krauze, F.; Laumanis, I. Ya.; Lielausis, O. A. (Inst. of Magnetohydrodynamics, Jena, Ger. Inst. of Physics, Riga). Dokl. Akad. Nauk SSSR, 180: 326-8(May 11, 1968). (In Russian).

The emf induced along the magnetic field in a conducting liquid in motion, with a velocity field not possessing a mirror symmetry, is proportional to the square of the velocity and to the magnetic field; it also increases with increasing Reynolds number. Experiments were carried out on this effect, using a spiral-symmetry velocity distribution of the liquid sodium flowing through the 152 × 152 × 515 mm^3 stainless-steel container from a closed loop. The magnetic field was created by a solenoid and could be adjusted from 0 to 0.3 Tesla. The temperature of the sodium was kept constant for each experiment at a temperature between 150 and 300°C. The flow was turbulent, with a Reynolds number Re $\approx$ (2 to 5) × 10^5; therefore the direct effect of the viscosity could be neglected. It was found that the chief determining factors were: induction, velocity, conductivity, and the linear dimensions of the system; their effect could be expressed as a dimensionless expression. The expression proved the existence of the α effect and supported the theory of self-excitation of the electromagnetic field. (TTT)

41423 SIMILAR SOLUTIONS FOR UNSTEADY MAGNETOHYDRODYNAMIC COUETTE FLOW. Sluyter, Marshall M. (Sandia Corp., Albuquerque, N. Mex.). Phys. Fluids, 11: 1832-3 (Aug. 1968).

Similar solutions are obtained for the unsteady magnetohydrodynamic Couette flow with suction. Both uniform and time-dependent magnetic fields are considered. It is shown that the magnetohydrodynamic flows can be obtained through the analysis of viscous flow. (auth)

41424 STRUCTURE OF TURBULENT HYDROMAGNETIC CHANNEL FLOWS. Harris, L. P. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Fluids, 11: 1833-5(Aug. 1968).

The predictions of velocity profiles in hydromagnetic channel flows derived during an earlier study compare satisfactorily with recent experimental measurements of Brouillette and Lykoudis. (auth)

41425 GENERAL TWO-DIMENSIONAL STEADY MAGNETOGASDYNAMIC FLOWS. Lynn, Y. M. (Univ. of Maryland, Baltimore). Phys. Fluids, 11: 1836-8(Aug. 1968).

Essential features of general two-dimensional steady magnetogasdynamic flows are shown. For the special class of zero transverse electric field flow, new invariants along streamlines and their intrinsic properties are given. (auth)

41426 HYDROMAGNETIC SURFACE WAVES IN A CONDUCTING LIQUID SURROUNDED BY A FLOWING GAS. Gerwin, Richard A. (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 11: 1699-1708(Aug. 1968).

The stability of the interface between a highly conducting liquid and a flowing, nonconducting gas is studied, supposing a magnetic field to be parallel to the interface. Arbitrary angles are allowed between magnetic field, flow direction, and wave vector. (auth)

41427 MHD FLOW IN RECTANGULAR CHANNEL WITH BLOWING THROUGH POROUS WALLS. Sych, V. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 85-92(Jan.-Mar. 1968). (In Russian).

The stationary flow of conducting liquids in rectangular channels with transverse magnetic fields, rectangular cross section, and blowing through the wall is investigated, except for the one-dimensional flow, by means of a direct variation method. The viscosity of the liquid and the conductivity of the channel walls, perpendicular to the external magnetic field, were taken into consideration. The results obtained were used for the determination of the loss in MHD generators. (tr-auth)

41428 INFLUENCE OF TRANSVERSE MAGNETIC FIELD ON THE VELOCITY PROFILE IN CIRCULAR PIPES. Ibrazimov, M. Kh.; Lozinov, N. I.; Subbotin, V. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 101-4(Jan.-Mar. 1968). (In Russian).

The results of the measurement of the velocity profile during flow of liquid metals in circular electroconducting pipes are reported. The measurement of the velocity was done by the electrodynamic method. The Stuart number was changed from 0.0141 to 1.61 and the Reynolds' number from 22,600 to 565,000. The results obtained are compared with the data for flow without magnetic fields. (tr-auth)

41429 LIQUID METAL OSCILLATION WITH CONSIDERATION OF MAGNETIC VISCOSITY. Krikun, Yu. A.; Kuksa, Yu. G.; Mikel'son, A. E.; Rezvitskii, V. A.; Chernyi, Z. D. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 105-8(Jan.-Mar. 1968). (In Russian).

The radial oscillations of liquid metal cylinders under the effect of axially constant and variable magnetic field are examined at small Reynolds' magnetic number and large Hartmann number. The volume electrodynamic force in the form of the skin effect is represented by δ functions. The expression for the hydrodynamic pressure is found after decomposition into eigenfunctions. (tr-auth)

41430 CONVECTION OF ELECTROCONDUCTING FLUID FLOW IN A LONG VERTICAL ANNULAR PIPE. Pisarev, N. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 109-13(Jan.-Mar. 1968). (In Russian).

The formation conditions and the flow character of the stationary thermal convection of liquids in a long vertical annular pipe with infinite thermoconducting walls are examined. The effect of the magnetic field of the current on the convection of the electroconducting liquid is taken into consideration. The current flows through the liquid along the pipe axis. It is shown that the formation of free convection depends on the Rayleigh number and in the case of the current passing through the liquid even more on the Hartmann number, during which the higher the latter, the higher the former should be. (tr-auth)

41431 THE FRINGE EFFECT IN MHD CONDUCTION MACHINES DURING SHUNTING OF PART OF THE CURRENT ALONG THE CHANNEL. Birzvalk, Yu. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 129-37(Jan.-Mar. 1968). (In Russian).

The problem on the distribution of the potential and on the calculation of the electromagnetic pressure in the channel of conducting liquid metal MHD machines is examined for the case when the flowing part consists of some sections or subchannels connected electrically in series. The potential difference causes the formation of parasite by-pass currents along the pipes connecting the subchannels. (tr-auth)

41432 ACCOUNT OF THE NATURAL MAGNETIC FIELD IN ONE-DIMENSIONAL FLOWS. Bertinov, A. I.; But, D. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 48-56(Jan.-Mar. 1968). (In Russian).

The plane one-dimensional MHD flow in channels at arbitrary Reynolds' magnetic number is examined with consideration of the closing of the strong lines of the natural field beyond the channel boundaries (magnetic scattering). Indications are that the natural field demagnetizes the channel during symmetrical scattering and reduces its power characteristics. General formulas of the distribution of the magnetic field in the channel, including the individual cases examined earlier, are derived. The optimization of the operating regime with respect to power, removable with electrodes, is worked out. The method for the integral determination of the magnetic resistance of the scattering is proposed. (tr-auth)

41433 EXPERIMENTAL INVESTIGATION OF LAMINAR MHD FLOW OF INCOMPRESSIBLE FLUID IN DIFFUSOR. Kukin, I. K.; Pankratov, O. S. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 57-64(Jan.-Mar. 1968). (In Russian).

A description is given of the experimental investigation of the laminar flow of incompressible electroconducting liquids (gallium) in plane diffusor in crossed electrical and magnetic fields. The values of the coefficients of resistance and longitudinal distribution of the potential difference on the electrodes of the channel are reported. The results obtained are compared with calculated values. (tr-auth)

41434 VELOCITY DISTRIBUTION IN A RECTANGULAR PIPE WITH THE NARROWEST SIDE NORMAL TO THE MAGNETIC FIELD. Branover, G. G.; Vasil'ev, A. S.; Tsinober, A. B.; Shkerstena, A. Ya. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 65-7(Jan.-Mar. 1968). (In Russian).

The calculations on the EVM of the velocity distribution in a rectangular pipe with low ratio of the side of the section installed in a transverse magnetic field were made on the basis of the precise Sherklif solution for a laminar flow regime. Experimental data on the effect of the transverse magnetic field on the flow velocity of a conducting liquid (mercury) in the center of a pipe with ratio of the sides $\beta = 0.133$ were also reported. It was established that the results of the experiments both in the turbulent and laminar regions agree well with the semi-empirical theory and the precise solution. (tr-auth)

41435 LIQUID METAL FLOW RESISTANCE IN A MAGNETIC FIELD. Vulis, L. A.; Paramonova, T. A.; Fomenko, B. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 68-74(Jan.-Mar. 1968). (In Russian).

The results of the generalization of the test data of different authors with respect to the flow resistance of liquid metals in magnetic fields oriented along the flow axis (B_x) or normal to the vector of the speed parallel to the long side of the rectangular channel (B_ϕ) are reported. Tests showed the critical character of the transition from laminar to turbulent flow in the ϕ field (for the case $a/b \gg 1$) and in longitudinal fields. For ϕ fields the test dependencies $\lambda = \lambda(R,H)$ for different values of the ratio of the sides a/b were compared. The values of the empirical coefficients in the interpolation formulas proposed earlier were made more precise. The results from the processing of the test data agreed with the representation of the previously developed phenomenological theory. (tr-auth)

41436 TURBULENT TWO-DIMENSIONAL FLOW IN TRANSVERSE MAGNETIC FIELD. Skurin, L. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 75-9(Jan.-Mar. 1968). (In Russian).

Questions, resulting from the semi-empirical turbulence theory using a two-layer scheme of turbulent flow, on the effect of a longitudinal magnetic force on the profile of the mean velocity and the friction on the walls during movement of conducting liquid between parallel plates are examined. The Reynolds' magnetic number is considered small. The turbulent friction is expressed by the Prandtl formula and the motion method is expressed by the Karman formula. It is shown that in the solution of such a problem for constantly large values of the Na number, monotonously increasing profiles of the mean velocity can not be obtained. (tr-auth)

41437 CALCULATION OF THE FLOW OF DISSOCIATED GASES IN MHD GENERATOR CHANNELS. Kostenko, P. P.; Frolov, S. D. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 20-6(Jan.-Mar. 1968). (In Russian).

The flow of dissociated equilibrium thermally inadequate gases in the presence of energy and mass exchange with the surrounding medium and manifestation of different conductivity strengths was calculated. New relations were obtained for the difference of the specific heat capacity, speed of sound, and differential enthalpy for dissociated gases. The conditions for collisionless transition of the flow through the speed of sound were examined. (tr-auth)

Geophysics

Refer also to abstracts 40365, 41175, 41250, and 41264.

41438 (BNWL-795) PROGRESS REPORT ON AERONOMY RESEARCH AT RICHLAND, WASHINGTON [JULY 1967-APRIL 1, 1968]. Hoch, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1968. Contract AT(45-1)-1830. 49p. Dep. CFSTI.

Among the main accomplishments of the 9-month period were: completion of the second meridian spectrograph and establishment of an observing program at the northern station in Banff, Alberta, Canada; completion of the laboratory and office facilities at the observatory on Rattlesnake Mountain; and acquisition and installation of the photometric apparatus at Boulder, Colorado. Work is proceeding on a tentative explanation of the stable auroral red arcs in terms of world-wide motions of the ionosphere, and progress has been made on the design and procurement of what will be a very advanced photometric scanning system. (W.D.M.)

41439 (N-68-15890) ROCKET OBSERVATIONS OF ELECTRON TEMPERATURE IN THE E REGION. Smith, L. G.; Weeks, L. H.; McKinnon, P. J. (GCA Corp., Bedford, Mass. GCA Technology Div.). Oct. 1967. Contract NASw-1402. 21p. (NASA-CR-92564; GCA-TR-67-13-N). CFSTI.

Electron temperature observations were obtained with Langmuir probes carried on sounding rockets, principally the Nike-Apache. A refinement of the instrumentation in which the rate of change of current is telemetered on a logarithmic scale has reduced the accuracy of individual measurements to ± 25°K compared with ±100°K obtained from direct analysis of the current-voltage characteristic. Rocket flights in Brazil during and following the solar eclipse of November 12, 1966, show that the electron temperature below 150 km remained constant; at greater heights a change of temperature was found, amounting to 300°K at 190 km. This supports the view that solar radiation does not directly determine the electron temperature of the E region. Electron temperatures are found always to be greater than the neutral gas temperature and, at a given altitude, the difference increases with increasing sunspot number. (auth) (STAR)

41440 (N-68-16837) AN ANALYSIS OF ENERGETIC SPACE RADIATION AND DOSE RATES. Burrell, M. O.; Wright, J. J.; Watts, J. W. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Feb. 1968. 63p. (NASA-TN-D-4404). CFSTI.

Presented is a compendium of the environmental data on trapped and untrapped radiation. It considers the calculated tissue dose rates received from these radiations and the induced secondary radiation behind various shield thicknesses. Energetic radiation, as used here, refers to particles with energies greater than about 0.5 MeV. The results should be of practical value for preliminary analysis of the radiation hazard to man during space flight. (auth) (STAR)

41441 (N-68-18182) OBSERVATIONS OF TRAPPED ELECTRONS AT LOW AND HIGH ALTITUDES. Williams, D. J.; Arens, J. F.; Lanzerotti, L. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight

Center). Feb. 1968. 79p. (NASA-TM-X-63121); X-611-68-63). CFSTI.

Simultaneous data are presented for trapped electrons at energies ≥ 280 keV as observed throughout much of the outer zone at 1100 km by the satellite 1963-38C and in the near equatorial regions by the Explorer 26 satellite. The observations were obtained during the time period January 1 through June 29, 1965, for the L values 3.0, 3.5, 4.0, 4.5, 5.0, and 5.5 earth radii. A comparison is made of the time behavior of electrons mirroring near the magnetic equator and those mirroring at low altitudes. Results and conclusions concerning the behavior of the trapped electron intensities during five well defined magnetic storms which were accompanied by electron intensity increases throughout much of the region of observation are discussed. (STAR)

41442 (N-68-18191) RAPID INCREASES IN THE PROTON AND ELECTRON FLUXES IN THE MAGNETOSPHERE. Konradi, Andrei (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1967. 31p. (NASA-TM-X-63125; X-611-67-521). CFSTI.

Three rapid increases in the low energy electron and proton flux were observed on October 27, October 28, and December 1, 1961. The time histories of the intensities and spectra are presented. The close association between the events and the occurrence of polar sub-storms is shown. The similarity of the events and those of December 20, 1962 and April 15, 1965 is discussed. It is also shown that the October 28, 1961 event is consistent with adiabatic acceleration of particles during a storm sudden commencement. (auth) (STAR)

41443 (N-68-18220) EXCITATION OF THE AURORAL GREEN LINE BY DISSOCIATIVE RECOMBINATION OF O_2^+: ANALYSIS OF TWO ROCKET EXPERIMENTS. Donahue, T. M.; Parkinson, T.; Zipf, E.; Fastie, W. G.; Miller, R. E. (Pittsburgh Univ., Pa. Space Research Coordination Center). Dec. 22, 1967. Contracts NASr-179; Nonr-624(06). 31p. (NASA-CR-93352; SRCC-64). CFSTI.

Analysis from photometric and electron flux data obtained during two sounding rocket auroral experiments yielded volume emission rates for the $N_2^+(0-0)$ first negative band and the O $I(^1S-^1D)$ green line among other emission features. It is shown that excitation of the green line by electrons would require a cross section an order of magnitude larger than expected. From a calculation of the O_2^+ production rate it is shown that dissociative recombination can account for the entire green line emission if one fifth of all O_2^+ recombinations excite the ^1S state. This is the laboratory measured value. Analysis also shows that this mechanism can describe the relative variation of λ3914 and λ5577 in time-varying auroras. (auth) (STAR)

41444 (N-68-20332) VARIATIONS OF THE MAGNETIC FIELD AT HIGH LATITUDES AND STRUCTURE OF THE GEOMAGNETIC FIELD IN THE MAGNETOSPHERE. Fel'dshteyn, Ya. I.; Zaytsev, A. I. Translated for Volt Technical Corp., Washington, D. C., from Kosm. Issled., 6: No. 1, 155-7(1968). 5p. (NASA-CR-93795; ST-GM-10693). CFSTI.

The magnetic field variations at high latitudes and the structure of the geomagnetic field in the magnetosphere are discussed in the light of equatorial boundaries of oval aurora zone, of westerly current vortex and of the equivalent current system DPC during IGY. Reference is also made to the three mechanisms responsible for the magnetic disturbance in the near-polar region. It is suggested that one of them is responsible for rapid phase variations of the perturbed vector, the other two for the appearance of DPC current system. (auth) (STAR)

41445 SPECTRAL ANALYSIS OF PEARLS. Jones, F. W.; Geldart, L. P. (McGill Univ., Montreal). Can. J. Phys., 46: 1449-53(June 15, 1968).

A method of analyzing pearls with an analogue computer is presented. Power density spectra of short, consecutive samples of data are obtained, and thus the time of occurrence of each frequency component during the event is determined. The relative power in each frequency component is also obtained. (auth)

41446 THE RAY THEORY OF DOPPLER FREQUENCY SHIFTS. Bennetti, J. A. (Univ. of Melbourne, Parkville, Victoria). Aust. J. Phys., 21: 259-72(June 1968).

A general expression is obtained according to ray theory for the Doppler frequency shift observed when both receiver and transmitter are in motion in a time-varying anisotropic but lossless medium. The result is obtained using Hamilton's optical method. The range of application of the resulting expression and its relationship to a number of published results are considered. The method of analysis is also applied to the calculation of the group path of a radio wave. (auth)

41447 SOME RESULTS OF IONOSPHERE INVESTIGATIONS AT NIRFI FOR 1957-1967. Benediktov, E. A.; Getmantsev, G. G.; Grishkevich, L. V.; Erukhimov, L. M.; Mityakov, N. A. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 169-90(1968). (In Russian).

An intensive study of the ionosphere was started in 1957 at the Institute, coinciding with the beginning of the International Geophysical Year. At first, vertical probes were used to obtain altitude-frequency data on the ionosphere and to study the drift of ionospheric inhomogeneities by means of discrete radioemission sources in the decameter wavelength range. The regular and irregular refraction of radiowaves at various zenithal angles was also measured. From 1961 on, the structure of the ionosphere was investigated by means of short and ultrashort signals emitted by Soviet and U. S. satellites, making use of the differential Doppler effect. Radioastronomical and probe techniques were used to determine the absorption of radiowaves in the ionosphere. The results obtained yielded valuable information on the main characteristics of the ionosphere during the last half-cycle of solar activity. A large portion of the systematic measurements on the integral electron concentration in the polar ionosphere, the location and the altitude of inhomogeneities in the electron concentration at temperate and polar latitudes, has not been published before. (Review article, 67 references). (TTT)

41448 ANGULAR ANISOTROPY OF CORPUSCULAR RADIATION IN STATIONARY GEOMAGNETIC FIELD. Pletnev, V. D.; Troshichev, O. A. Kosm. Issled., 6: 471-3(May-June 1968). (In Russian).

The distribution of intensity of radiation captured in the geomagnetic field is expressed by the function f(r,v,t) describing the rate of particle distribution as a function of the coordinate of the examined point and time. In a dipole field, due to axial symmetry, the distribution function coordinate was reduced to the functions of r_e and s where r_e is the distance from the dipole axis to the corresponding energy line measured in the equatorial plane, and s is the length of the energy arc line from the equatorial plane of the assigned point. An equation was written out by E. N. Parker (Phys. Rev., 107, No. 4, 924, 1957) for rate distribution of identical energy charged particles along fixed magnetic energy lines independent of time: $f(s,\theta) = K_\alpha[B_e/B(s)]^{(\alpha+1)/4} \sin^\alpha\theta$ (where B is the magnetic field value at $s = 0$, α is the arbitrary constant, and K_α is the coefficient as a function of α). An attempt is made here to show that the simplified solution obtained by Parker is only a particular case of the more general solution. (R.V.J.)

41449 EFFECT OF MAGNETIC ACTIVITY ON HORIZONTAL DRIFTS IN THE F2 REGION AT WALTAIR. Rao, P. S. Kesava; Rao, B. Ramachandra (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 6: 149-50(1968).

The effect of magnetic activity on F2-region drifts at Waltair (17°43'N.; 83°18E.; geomag. lat. 7.4°N.) was studied utilizing the F2-region drift data taken during the period 1962-64 using the spaced receiver method. It is found that F2-region drift velocity increases with magnetic activity. Resolving all the available drift velocities into N-S and E-W components, the effect of magnetic activity on each of these components was studied. It was found that the N-S component is towards south for K indices in the range 1 to 2.5 and towards north for higher K indices. The E-W component is found to be towards east for K indices lying between 1 and 4 and west for higher K indices. (auth)

41450 EXCITATION OF THE AURORAL GREEN LINE BY DISSOCIATIVE RECOMBINATION OF THE OXYGEN MOLECULAR ION: ANALYSIS OF TWO ROCKET EXPERIMENTS. Donahue, T. M. (Univ. of Pittsburgh); Parkinson, T.; Zipf, E. C.; Doering, J. P.; Fastie, W. G.; Miller, R. E. Planet. Space Sci., 16: 737-47(June 1968).

Analysis from photometric and electron flux data obtained during two sounding rocket auroral experiments has yielded emission rates for the $N_2^+(0-0)$ first negative band and the $OI(^1S-{}^1D)$ green line, among other emission features. It is shown that excitation of the green line by electrons would require a cross section an order of magnitude larger than expected. From a calculation of the O_2^+ production rate it is shown that dissociative recombination can account for the entire green line emission if one fifth of all O_2^+ recombinations excite the ^1S state. This is also the laboratory measured value. Analysis also shows that this mechanism can describe the relative variation of λ3914 and λ5577 in time-varying auroras. (auth) (UK)

41451 SPORADIC IONIZATION OF THE E REGION ACCORDING TO OBSERVATIONS AT MIRNY 1962. Zborovskaya, I. M. Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.), 6: 228-30 (Jan. 1968).

The results of a statistical study of sporadic ionization in the E region are reported. Analysis of the relation of the E_s layer

to auroras showed that sporadic ionization in the E layer coinciding in time with auroras varies, depending on the forms and location of auroras. All forms of auroras of brightness 2 to 4 at the zenith are accompanied by reflections from an E_s layer of the a type. Auroras of low brightness at the zenith are accompanied by flat types of E_s with clear multiple refractions or by types f and a reflections with poorly defined forms. Auroras at the horizon are accompanied by flat E types or there is no sporadic ionization in the E region. In this period ionograms sometimes show oblique traces extending from 150 to 500 Km. Two groups of sporadic ionization types are characteristic for Mirny: flat f, l, c types and the auroral, a, type. Type c amounts to 14% of the total number of E_s and is observed mainly in summer. There are two maxima in the diurnal probability of appearance of E_s of the c type: at 6 and 14 hr local time. The degree of transparency of the sporadic layer was determined. The probability of appearance of type a sporadic ionization has the same value frequency of appearance of E_s of the flat types f and l. Seasonal distribution and diurnal variations were also studied. (BBB)

41452 THEORETICAL STUDY OF THE MAGNETIC FIELD IN THE LUNAR WAKE. Whang, Y. C. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids, 11: 1713-19(Aug. 1968).

When the solar wind interacts with the moon, the plasma shadow region on the dark side of the moon forms a long lunar wake. In the plasma umbra a detectable plasma flow is absent and in the penumbra the plasma flux increases from the void condition in the umbra to the interplanetary condition outside. A theoretical model for perturbations of the magnetic field in the plasma shadow is studied by directly solving Maxwell's equations for steady-state solutions. The perturbation of the field is assumed to be due to the magnetization current, the gradient drift current, and the curvature drift current. Numerical solutions are obtained to describe the variations of the magnetic field, and the results are in good agreement with experimental observations from the Explorer 35 satellite. (auth)

41453 THE EFFECT OF DIURNAL TEMPERATURE CHANGES ON THE F2-LAYER. II. TEMPERATURE DEPENDENT LOSS RATE. Thomas, G. R. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 1429-37(July 1968).

Time-varying solutions obtained for the F2-region continuity equation under conditions of thermal nonequilibrium are described. It is assumed that the rate coefficient of the ionization loss process varies with temperature, as suggested by recent laboratory measurements, and it is shown that this produces an evening increase of electron density in summer. It is also shown that seasonal variations of electron temperature may contribute to the "seasonal anomaly" in F2-region electron densities. (auth) (UK)

41454 IONIZATION CHANGES IN THE MIDDLE LATITUDE D-REGION ASSOCIATED WITH GEOMAGNETIC STORMS. Belrose, J. S.; Thomas, L. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 1397-1413(July 1968).

The effects of magnetic storms on the middle latitude D region over Europe were examined using observations of transmissions over short paths of vlf, lf and mf radio waves, and vertical incidence measurements of absorption at mf and hf. These data reveal pronounced effects associated with certain storms, effects which persist for several days after the recovery of the geomagnetic field. The vlf amplitude measurements show little change from the normal day behavior, but the phase measurements show rapid fluctuations during the magnetic storm and an anomalous diurnal variation during the days following the recovery of the geomagnetic field. At lf the amplitude shows rapid fluctuations during the magnetic storm and severe attenuation after the recovery of the field. These effects at vlf and lf are most marked during twilight and night hours, and are usually absent at noon. The observations at mf and hf were confined to noon periods but show marked increases of absorption following the recovery of the geomagnetic field and sometimes during the storm itself. It is suggested that the anomalous ionization giving rise to increased absorption at mf and hf near noon normally occurs above the reflection level of the vlf and lf waves which is about 80 to 90 km. Mechanisms proposed to account for these effects are outlined, and the possible importance of storm effects to the winter anomaly in ionospheric absorption is considered. (auth) (UK)

41455 CONTOUR MAPS OF THE EQUATORIAL ELECTROJET. Hall, S. H. (Imperial Coll. of Science and Tech., London). J. Atmos. Terrest. Phys., 30: 1293-1300(July 1968).

The magnetic elements tabulated for the four I.G.Y. Pacific observatories of Guam, Koror, Fanning, and Jarvis Islands are used to produce contour charts of the diurnal variation field by the method of projecting the observatory on to a geocentric sphere which is stationary with respect to the Sun. The observatory thus plays the reverse role of a satellite in tracing a path on the geocentric sphere. Trajectories are calculated for each month, and the mean hourly departures of the diurnal field obtained from the tabulated observations, when inserted on these trajectories, produce contoured zone charts 47° wide of the electrojet and equatorial S_q fields. ΔD charts for these observatories exhibit principally equatorial S_q field features, but ΔH charts show that the annual character of the horizontal field at the dip equator is controlled to a large extent by the solar zenith angle during the greater part of the year but during the J months there is a distinct modification of this influence. (auth) (UK)

41456 PERIODIC FADING OF IONOSPHERIC ECHOES. Essex, Elizabeth A. (Univ. of the West Indies, Kingston, Jamaica). J. Atmos. Terrest. Phys., 30: 1441-3(July 1968).

A peculiar periodic fading of ionospheric echoes from E, E_s and F regions is described. The fading is sometimes present on one magneto-ionic component alone. (auth) (UK)

41457 THE DEPENDENCE OF IONOSPHERIC ABSORPTION OF MF RADIO WAVES AT MID-LATITUDES ON PLANETARY MAGNETIC ACTIVITY. Bourne, I. A.; Hewitt, L. W. (Defence Research Telecommunications Establishment, Ottawa). J. Atmos. Terrest. Phys., 30: 1381-95(July 1968).

A statistical analysis of mf radiowave absorption data at middle European latitudes shows that there is a positive short-term correlation (i.e., for periods of up to 30 days) with solar activity and planetary magnetic activity. The maxima and minima in mid-latitude absorption, however, occur several days after the corresponding K_p variations. Since the effects are more pronounced in autumn and winter than in spring and summer, this may explain some of the published reports of anomalous winter absorption in Europe. (auth) (UK)

41458 ANOMALOUS VARIATIONS OF THE IONOSPHERIC TOTAL ELECTRON CONTENT AT SUB-AURORAL LATITUDES. Earnshaw, R. D. S.; Taylor, G. N. (Univ. of Manchester, Jodrell Bank, Eng.). J. Atmos. Terrest. Phys., 30: 1369-79 (July 1968).

Previous measurements of Faraday rotation in vhf lunar radar echoes (Taylor, 1965) revealed large anomalies of the ionospheric total electron content in the sub-auroral region. Further observations have allowed a detailed analysis to be made. The anomalies occur between L values of 3.0 and 4.5, and their geomagnetic latitudes show strong inverse correlation with the average value of K_p in the previous 24 h. It is shown that the apparent absence of any anomaly on many days is consistent with the anomalous region having moved too far northwards to be seen. The effect is caused by large scale distortions of the F region, of which the most persistent and characteristic feature is the main trough. The apparent magnitude of the anomalies is considerably increased by the breakdown of a conventional simplifying assumption about the magnetic field function which is used to convert measured Faraday rotation to electron content. Anomalies were observed at times of day when the trough was not present, and it is probable that the causative ionospheric distortion is present at all times of day and year. The results are compared with electron content measurements at higher latitudes and with the behavior of the plasmapause. (auth) (UK)

41459 RADIO WAVE ABSORPTION IN MODEL IONOSPHERIC LAYERS. Jain, A. R.; Setty, C. S. G. K. (Univ. of Delhi). J. Atmos. Terrest. Phys., 30: 1353-67(July 1968).

Absorption suffered by a radio wave reflected in or passing through a Chapman layer approximating to either D or E layers at noon, for the overhead Sun, was calculated graphically for the ordinary wave as a function of frequency for geomagnetic conditions appropriate to Delhi (f_H = 1.20 Mc; magnetic dip = 42.44°). The absorption coefficients used in this calculation were computed using the Appleton–Hartree formula. Absorption was also computed using several approximate formulae in common use. Comparison between the absorptions calculated using the Appleton–Hartree formula and the other approximate formulae was made to ascertain the applicability of the approximations involved. (auth) (UK)

41460 MORPHOLOGY OF AURORAL ZONE RADIOWAVE ABSORPTION IN THE ALASKA SECTOR. Hook, J. L. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 30: 1341-51 (July 1968).

Particle precipitation patterns in the auroral zone were derived from an investigation of radiowave absorption at about 30 Mc from a network of riometer stations located in Alaska. Aurorally associated absorption occurs mainly along a circular zone centered at 66°N geomagnetic latitude and having a width of approximately 10°. This circular structure contrasts with the oval structure

revealed by visual auroral displays and magnetic activity. These two zones are nearly coincident on the midnight meridian, but the visual auroral zone is located at about 77°N geomagnetic latitude on the day side. Eight years of data show that the absorption decreases by a factor of two from the sunspot maximum to minimum (1958–1964). During this period of declining solar activity the center of the auroral absorption zone moved from approximately 65°N to 66.5°N geomagnetic latitude. (auth) (UK)

41461 PITCH ANGLE DIFFUSION OF LOW-ENERGY PROTONS DUE TO GYRORESONANT INTERACTION WITH HYDROMAGNETIC WAVES. Gendrin, R. (Groupe de Recherches Ionospheriques, Saint Maur des Fosses, France). J. Atmos. Terrest. Phys., 30: 1313-30(July 1968).

Using a hydromagnetic approximation for the two circularly polarized waves that can be propagated longitudinally in a cold magnetoplasma, the frequencies that are emitted by gyroresonance processes involving low energy proton beams ($E \lesssim 100$ keV) were derived. The reaction of the generated waves on the particles was evaluated and the resulting trajectories of these particles in their velocity space were computed; they differ greatly from circles centered at the origin. The pitch-angle diffusion coefficient that can then be deduced is different also from the simple coefficient that is generally used: it is greater for (p,L) interactions, and lower for (p,R) interactions. The importance of the energy diffusion in such interaction processes is stressed, and orders of magnitude are given. In an Appendix, a general diffusion equation for this type of interaction is established. (auth) (UK)

41462 ROCKET OBSERVATIONS OF ELECTRON TEMPERATURE IN THE E-REGION. Smith, L. G.; Weeks, L. H.; McKinnon, P. J. (GCA Corp., Bedford, Mass.). J. Atmos. Terrest. Phys., 30: 1301-12(July 1968).

Electron temperature observations were obtained with Langmuir probes carried on sounding rockets, (principally the Nike Apache). Flights in Brazil during and following the solar eclipse of November 12, 1966 showed that the electron temperature below 150 km remained constant; at greater heights a change of temperature was found, amounting to 300°K at 190 km. This supports the view that solar radiation does not directly determine the electron temperature of the E region. Electron temperatures are always found to be greater than the neutral gas temperature and, at a given altitude, the difference increases with increasing sunspot number. (auth) (UK)

41463 PHOTOELECTRON ESCAPE FROM THE IONOSPHERE. Nisbet, John S. (Pennsylvania State Univ., University Park). J. Atmos. Terrest. Phys., 30: 1257-78(July 1968).

Photoelectron fluxes escaping from the ionosphere into the magnetosphere are calculated including the effect of photoelectron diffusion for a range of solar activity. The method employs a two-dimensional matrix of continuity equations. In the region where the mean free path of the photoelectrons is small compared with the scale height, the predominant term in the transport equation is the upward diffusion flux. As the altitude increases three components of the flux can be considered, an upward escaping component, an upward nonescaping component, and a downward component. The relation between these fluxes, the heating of the protonosphere, and the photoelectron fluxes at the far end of the field line are examined. (auth) (UK)

41464 CALCULATION OF ELECTRIC CURRENTS IN THE IONOSPHERE BY AN EQUIVALENT CIRCUIT METHOD. Stening, R. J. (Univ. of Queensland, St. Lucia, Australia). Planet. Space Sci., 16: 717-28(June 1968).

A method is presented for calculation of current flows in the ionosphere giving the conductivity and wind velocity distributions. An equivalent circuit is set up to represent the ionospheric conditions, with the inclusion of the Hall effect. Further refinements include the removal of the restriction on vertical current flow by considering the currents flowing across a whole tube of magnetic force. Methods for taking account of the vertical variation of wind velocities and for determining seasonal variations of the current pattern are mentioned. As an example the calculation of the current pattern due to a simple semidiurnal wind yields a result the form of which is in accord with observations. (auth) (UK)

41465 ROCKET MEASUREMENTS OF THE ALTITUDES OF THE LAYERS EMITTING THE 5577 A LINE OF OXYGEN AND THE CONTINUUM IN THE NIGHT AIRGLOW. Best, G. T. (Air Force Cambridge Research Labs., Bedford, Mass.). Planet. Space Sci., 16: 821-4(June 1968).

Five dc photometers were flown in a Skylark rocket, SL13, at Woomera, Australia, at 20.30 local time, on August 26, 1960. A short flight history is given and the data obtained are analyzed and tabulated. (UK)

41466 AURORAL X-RAYS AND THEIR ASSOCIATION WITH RAPIDLY CHANGING AURORAL FORMS. Pilkington, G. R.; Anger, C. D.; Clark, T. A. (Univ. of Calgary, Alberta). Planet. Space Sci., 16: 815-17(June 1968).

Experimental investigations of the association between bremsstrahlung x rays, detected at balloon altitudes in and around the auroral zones, and visible aurora have led to varied conclusions. This paper describes results obtained with a device which was capable of recording pictures of faint aurora at the rate of several per second on film or magnetic tape. The apparatus was operated at Fort Churchill, Manitoba, on the night of 21–22 April, 1964, during the test flight of a prototype x-ray balloon-borne detector. The results, obtained during an 8-min auroral breakup, suggested a close association between x rays detected at balloon altitudes, and particular types of visible aurora. (UK)

41467 H_β RADIATION IN THE SPECTRUM OF THE NIGHT SKY. Hindle, P. H.; Reay, N. K.; Ring, J. (Univ. of Hull, Eng.). Planet. Space Sci., 16: 803-8(June 1968).

Observations with a Fabry–Perot interferometer of the spectral region centered on H_β (4861.33 Å) in the spectrum of the night sky and zodiacal light are described. Of the twelve scans obtained after the end of evening twilight all showed a small emission component, and in those obtained well clear of the plane of the Galaxy emission rates of typically 0.1 Rayleighs were measured. (auth) (UK)

41468 MEASUREMENTS OF THE H_β PROFILE IN THE ZODIACAL LIGHT SPECTRUM. Daehler, Mark (Univ. of Wisconsin, Madison); Mack, J. E.; Stoner, J. O. Jr.; Clarke, D.; Ring, J. Planet. Space Sci., 16: 795-801(June 1968).

In connection with a study of the particles causing the zodiacal light, an attempt was made to obtain a profile of the H_β (4861 Å) absorption line in the zodiacal light spectrum. The experiment was performed at Mt. Chacaltaya, Bolivia (altitude 5200 m, latitude 16°21′ S), with a high-luminosity, photoelectric Fabry–Perot spectrometer providing a resolution of about 3300. The absorption feature was obscured by H_β emission of uncertain origin, preventing precise Doppler-shift measurements of the absorption feature. The emission featured showed no wavelength shift, and its relative intensity varied with elongation, reaching a maximum at about 70°, and was greater in the morning than in the evening. At maximum, the intensity of the H_β emission was roughly five Rayleighs at the bottom of the atmosphere. (auth) (UK)

41469 LATITUDE VARIATION OF SCINTILLATIONS OF IONOSPHERE ORIGIN IN SATELLITE SIGNALS. Planet. Space Sci., 16: 775-81(June 1968).

A cooperating group of European and American observatories has made observations of scintillated 54-MHz signals from the satellite Transit 4A and of 40 MHz signals from the ionospheric beacon satellite S-66 (BE-B). Analysis of the data shows that the statistical behavior of the ionospheric irregularities causing scintillation can be represented by a smooth latitude function which displays increasing depth of scintillation near the northern auroral region. For mid-latitude stations, observations away from the zenith may be interpreted as a geometric modification of the smooth latitude dependence but the behavior of off-zenith observations made near the auroral zone is speculative. (auth) (UK)

41470 HYDROGEN ION VELOCITY DISTRIBUTIONS IN THE IONOSPHERE. Banks, Peter M. (Univ. of California, San Diego). Planet. Space Sci., 16: 759-73(June 1968).

The detailed velocity dependence of the hydrogen ion distribution function was obtained through numerical solutions to the steady state Boltzmann equation for conditions of ionospheric interest. The processes of electron–H^+, H^+–O^+ and charge exchange collisions between atomic oxygen and hydrogen ions and atoms were included in the collision model. The results indicate that the H^+ velocity distribution is somewhat distorted from the Maxwellian and lead to a H^+ kinetic temperature up to 350°K hotter than that of the ambient O^+ gas. The general trend of the H^+ distribution function shows there are fewer particles in the low velocity regions and an enhancement in the tail of the distribution, as compared with a Maxwellian distribution having the same kinetic temperature. The application of these results to ionospheric measurements is discussed. (auth) (UK)

41471 MAGNETOSPHERIC RADIATION BELT AND TAIL PLASMA SHEET. Piddington, J. H. (Univ. of Iowa, Iowa City). Planet. Space Sci., 16: 703-16(June 1968).

Theories of the origin of the storm-time radiation belt (the ring current) and associated bays and auroras have invoked hydromagnetic flow from the magnetotail on the one hand and flow into the tail on the other. It is shown that both flow patterns occur, the inward flow being the source of energy and driving the major magnetospheric convection pattern. Inward flow is the source of lower-energy ($E \simeq 10$ keV) auroral particles, of the asymmetric or storm-time radiation zone and higher-energy ($E \lesssim 20$ keV)

trapped particles, and of the permanent radiation belt itself. When the asymmetric belt develops sufficient energy density ($\gtrsim 10^{-8}$ erg/cm^3) an electric space-charge field develops which changes the plasma convection pattern and ionospheric current system. The following phenomena are thus explained: (a) The tail plasma sheet is formed by the outward Hall drift of plasma from the storm-time radiation zone. (b) On a smaller scale, "bubbles" of plasma from the radiation zone are released into the tail, accounting for the observed "islands" of tail electrons, "spikes" of electrons seen just above the ionosphere, and energetic protons ($\gtrsim$300 keV) which have been seen in the tail. (c) The storm or bay ionospheric current system (DP1) develops from the quiet-time system (DP2) as a result of the magnetospheric space-charge field and changed ionospheric conductivity caused by auroral precipitation. (d) Quiet auroral arcs and auroral substorms are due to electron precipitation from regions of low magnetic field strength, where the first invariant (of trapped particles) is lost. The intermittent ejection of plasma from the radiation belt suggests that the model be termed the "burping radiation belt." (auth) (UK)

41472 THEORY OF ELECTROMAGNETIC FIELD PROPAGATION IN MAGNETOSPHERE. Savin, M. G. (Inst. of Physics of the Earth, Moscow). Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 7, 98-102(July 1968). (In Russian).

The method of D. N. Chetaev (Dokl. Akad. Nauk SSSR, 174: No. 4, 1967) is used for resolving the problem of plane electromagnetic wave propagation in horizontally stratified plasma in the magnetosphere, with an arbitrary orientation of the wave vector K and external magnetic field H. The problem is reduced to a system of linear algebraic equations in relation to the vector potential components. (R.V.J.)

41473 HIGH-SENSITIVITY SATELLITE-BORNE TELEVISION CAMERA FOR THE DETECTION OF AURORAS. Mende, S. B.; O'Brien, B. J. (Rice Univ., Houston, Tex.). Appl. Opt., 7: 1625-34(Aug. 1968).

A high sensitivity satellite-borne television camera has been developed to measure such faint light sources as auroras. A secondary electron conduction (SEC) television camera tube is used as the image sensor. In the present application for the Rice/NASA satellites code-named Owls, the tube is exposed by the application of a high voltage pulse of 0.1 sec or 0.2 sec duration. The picture is scanned for about 19 sec, and the video is digitized in synchronism with the satellite PCM system. The television data are then telemetered to the ground either real time or stored in one of the tape recorders. The optical system superimposes star images on the picture for azimuthal aspect reference. The sensitivity of the slow scan camera was measured; it agrees with the sensitivity of a camera scanning at normal scan rate. Comparison was made of the relative sensitivity of the camera at the wavelength of the three most important auroral components. The camera has sensitivity comparable with the dark-adapted human eye. The weight of the system is 3.9 kg, and the power dissipation is 3.9 W. (auth)

41474 EFFECTS OF FIELD-ALIGNED CURRENTS ON THE STRUCTURE OF THE IONOSPHERE. Block, L. P.; Faelthammar, C.-G. (Royal Inst. of Tech., Stockholm). J. Geophys. Res., 73: 4807-12(Aug. 1, 1968).

The influence of electric currents along the magnetic field lines on the high-latitude F-layer ionosphere was investigated theoretically. It is shown that a current of either sign leads to a reduction of the total electron content and the maximum density, if the charge carriers have to be produced in the ionosphere. Low-energy precipitation leads to a corresponding increase. Extremely low densities in the topside ionosphere may be reached for ion currents of the order of 10^{-6} amp/m^2 or electron currents of 10^{-3} amp/m^2. Observational evidence exists for currents at least of the order of 10^{-6} amp/m^2. It is suggested that the ionospheric trough, the F-layer storm, and other similar effects may be explained by field-aligned currents or plasma diffusion, which is also quantitatively accounted for by the present theory. (auth)

41475 MODEL OF MAGNETOSPHERIC TEMPERATURE DISTRIBUTION. Mayr, H. G.; Volland, H. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 4851-8(Aug. 1, 1968).

In the magnetosphere, the equation of heat flux parallel to the magnetic field must be modified because of the low electron concentration and large mean free path. This leads to a density-dependent heat conductivity that is decreased such that the high temperatures in the magnetosphere observed by Serbu and Maier can be explained. In the upper magnetosphere, turbulent heat transfer in accordance with Bohm's diffusion coefficient can account for heat fluxes on the order of 10^{-10} erg/cm^2 sec (6.1×10^1 eV/cm^2 sec) across the magnetic field. Such heat fluxes are consistent with ion–electron temperature differences of Ti – Te = 10^{6}K also discovered by Serbu and Maier. This direct thermal energy input is negligible for the energy balance of the magnetosphere when compared with the heat fluxes of 10^{-3} to 10^{-2} erg/cm^2 sec generated through nonlocal heating by fast ionospheric electrons. (auth)

41476 HIGHER ORDER CYCLOTRON HARMONIC RESONANCES AND THEIR OBSERVATION IN THE LABORATORY AND IN THE IONOSPHERE. Shkarofsky, I. P. (Radio Corp. of America, Montreal). J. Geophys. Res., 73: 4859-67(Aug. 1, 1968).

It is shown that the $n\omega_b$ resonances for $n > 2$ are limited in time response by cyclotron damping resulting from finite $k_{||}$ values. In the laboratory, the minimum $k_{||}$ value is determined by the finite size of the apparatus, whereas in space it is limited by the non-uniformity of magnetic field along a field line. Persistence times in space of the order of 1 msec and a magnetic-latitude dependence in rough agreement with Alouette 1 measurements were obtained. (auth)

41477 UNDUCTED WHISTLER EVIDENCE FOR A SECONDARY PEAK IN THE ELECTRON ENERGY SPECTRUM NEAR 10 keV. Thorne, Richard Mansergh (Stanford Univ., Calif.). J. Geophys. Res., 73: 4895-4904(Aug. 1, 1968).

Resonant particle interactions between unducted, magnetospherically reflected (MR) whistler-mode radiation and the ambient plasma were investigated. Because the frequencies of such waves are small compared to the local electron gyrofrequency and the wave normals practically perpendicular to the magnetic field, Landau electron interactions dominate. Resonant ion energies are well above 1 MeV and can consequently be ignored. The upper and lower frequency cutoffs, as well as the high-frequency region of growth of the multiple bounce MR traces observed near L = 2.5, can be accounted for by an ambient electron distribution that has a secondary peak in the vicinity of 10 keV. (auth)

41478 DIURNAL VARIATION OF THE INTENSITY AND ENERGY SPECTRUM OF LOW-ENERGY ELECTRONS INCIDENT AT FORT CHURCHILL, CANADA. Webber, W. R. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 73: 4905-13(Aug. 1, 1968).

Measurements are reported of the intensity and energy spectrum of electrons incident at Fort Churchill, Canada, which confirm and extend the observations of a large diurnal intensity variation reported by Jokipii, L'Heureux, and Meyer (1967). From the observations it is concluded that: (1) the effective daytime cutoff near Fort Churchill is ~160 MV, (2) the nighttime cutoff is ~15 MV but may fluctuate with time, and (3) the transition from day-to-night conditions occurs within a period of one hour between 1800 and 1900 hours local time. These results are related to the predictions of recent calculations based on the entrance of particles through the magnetospheric tail and their subsequent motion in the geomagnetic cavity. The re-entrant albedo intensity between 16 and 160 MeV present in the daytime is compared with other observations of these particles at lower latitudes. The extraterrestrial electron intensity present at night between 15 and 160 MeV is obtained and found to be substantially lower than previous observations have indicated. (auth)

41479 OBSERVATIONS OF ENERGETIC ELECTRONS AT SYNCHRONOUS ALTITUDE. I. GENERAL FEATURES AND DIURNAL VARIATIONS. Paulikas, G. A.; Blake, J. B.; Freden, S. C.; Imamoto, S. S. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res., 73: 4915-25(Aug. 1, 1968).

Energetic electron fluxes above four integral thresholds ($E_e >$ 300 keV, > 450 keV, 1.05 MeV, and 1.9 MeV) were measured at synchronous altitude ($R = 6.6\ R_E$) during the first half of 1967 on board the ATS 1 satellite (1966-110A). The fluxes show a diurnal variation with the noon-to-midnight ratio being larger for the more energetic electron groups and being larger, on the average, for magnetically disturbed days. Magnetic storms produce a great deal of fine structure in the electron fluxes, with changes occurring on the time scale of minutes; the effect of such storms is to depress the fluxes. Recovery to prestorm level is an energy-dependent process that proceeds more slowly for more energetic electrons and apparently in a stepwise manner. (auth)

41480 MODEL FOR THE GENERATION OF MAGNETOHYDRODYNAMIC WAVES BY HIGH-ALTITUDE NUCLEAR BURSTS. Lutomirski, R. F. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 73: 4943-58(Aug. 1, 1968).

A model for the debris motion promptly following a high-altitude nuclear detonation is taken to be a perfectly conducting sphere expanding at constant velocity into a magnetoplasma, pushing the magnetic field aside, and then abruptly stopping. Representing the electromagnetic properties of the magnetoplasma by a dielectric sensor, Maxwell's equations can be written as two coupled equations for the isotropic and anisotropic modes of propagation. Using a perturbation expansion, these equations can be solved for the two modes as a function of the debris expansion velocity, which can in

turn be related to the yield-to-mass ratio of the bomb. The analyses permit evaluation of the amplitude, the spatial and temporal dependence, and the frequency content of the hydromagnetic signal generated by the explosion. The model also yields a physical interpretation of that portion of the hydromagnetic yield that does not appear as radiation and allows evaluation of the efficiency of the system as a radiator of hydromagnetic waves. (auth)

41481 OBSERVATION OF STRONG THERMOSPHERIC WINDS DURING A GEOMAGNETIC STORM. Smith, Lawrence B. (Sandia Corp., Albuquerque, N. Mex.). J. Geophys. Res., 73: 4959-63 (Aug. 1, 1968).

A description is given of an apparently anomalous wind in the thermosphere that occurred near the time of an intense geomagnetic storm. The circulation was very strong and showed a linear increase with height. Although no causative relationship is proven, certain qualitative aspects of the wind direction and its variation with height indicate reasonable agreement with a suggested model. (auth)

41482 DYNAMIC MODEL OF IONOSPHERIC WIND PROFILES. Rosenberg, Norman W. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 73: 4965-8(Aug. 1, 1968).

A statistical analysis of velocity, shear, and wavelength versus altitude has recently been reported for 70 wind profiles observed at midlatitudes between 90- and 150-km altitude. Hines had previously considered theoretically the characteristics of a rotating wind vector with energy supplied from below and viscous loss within the region. The present paper predicts profiles from this model with two assumptions: (1) the viscosity varies from tenfold molecular viscosity at 90 km (because of turbulence) to its molecular value at all heights above 105 km, and (2) the time constant for supply of energy is semidiurnal. These two assumptions lead to altitude dependence of speed, shear, wavelength, and energy content and dissipation, which are substantially identical to those obtained by the statistical analysis. (auth)

41483 ROCKET MEASUREMENT OF ELECTRON AND PROTON INTENSITIES IN A MAGNETIC DISTURBANCE. Vancour, Roger P. (Air Force Cambridge Research Labs., Bedford, Mass.); Sellers, Bach; Hanser, Frederick A. J. Geophys. Res., 73: 4979-85(Aug. 1, 1968).

A study was undertaken of auroral precipitating fluxes and local magnetic field perturbations by launching a series of Javelin and Nike Iroquois rockets into auroras accompanied by large magnetic disturbances. Simultaneous measurements of electron and proton fluxes and of the magnetic field are made. The results of particle measurements on the first flight, a Javelin rocket, are reported. (W.D.M.)

41484 FINE STRUCTURE OF THE EARTH-IONOSPHERE CAVITY RESONANCES. Larsen, T. Roeed; Egeland, A. (Univ. of Oslo). J. Geophys. Res., 73: 4986-9(Aug. 1, 1968).

Since the fundamental paper by Schumann (1952), much experimental and theoretical work has been carried out in investigating the natural resonances of the Earth–ionosphere waveguide. While the gross feature of this resonance problem is not fairly well understood, considerable work remains before all details about the phenomenon are explained. The aim of this paper is to present some measurements performed at high latitudes. Special emphasis is given to short-period variations observed in the spectra of the first resonant mode. (W.D.M.)

41485 RESPONSE OF IONOSPHERIC AND EXOSPHERIC ELECTRON CONTENTS TO A PARTIAL SOLAR ECLIPSE. Fritz, R. B.; Schiffmacher, E. R.; Hargreaves, J. K. (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 73: 4994-8(Aug. 1, 1968).

This note describes the observations made using the radio beacon transmitters aboard the OGO1 satellite at the time of the partial solar eclipse of May 9, 1967, for which the maximum obscuration near the peak of the ionospheric F2 region was 41%. (W.D.M.)

41486 He_2^+ IN THE TOPSIDE IONOSPHERE. Banks, Peter M. (Univ. of California, San Diego, La Jolla); McGowan, J. William. J. Geophys. Res., 73: 5008-11(Aug. 1, 1968).

On many occasions at altitudes above 500 km an ion with M/Z = 8 amu is observed in concentrations reaching 200/cm^3 when the total ion concentration is ~3000/cm^3. Hoffman (1967), in a preliminary analysis of Explorer 31 data, tentatively identified this ion as O^{2+} rather than He_2^+. The object of this note is to point out the difficulties associated with the identification of the M/Z = 8 amu ion as either O^{++} or He_2^+, and to suggest on the basis of reported satellite ion current modulation curves that the He_2^+ identification may be the correct choice for this ion. (W.D.M.)

41487 RELATION BETWEEN GEOMAGNETIC SUDDEN IMPULSES AND SOLAR WIND PRESSURE CHANGES: AN EXPERIMENTAL INVESTIGATION. Siscoe, G. L.; Formisano, V.; Lazarus, A. J. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 4869-74(Aug. 1, 1968).

Theoretically the relation between the size of a geomagnetic sudden impulse, si, and the associated change in the solar wind stagnation pressure, P_s, is given by $si = k\{[P_s(2)]^{\frac{1}{2}} - [P_s(1)]^{\frac{1}{2}}\}$ where (1) and (2) refer to pressures before and after the event and k is a proportionality constant. k was determined experimentally using the M.I.T. solar wind measurements on Pioneer 6. The results support the general functional relation given; however, the experimental value for k is approximately ½ that expected theoretically. This discrepancy was also found in a direct comparison of geomagnetic field strength and different solar wind pressures on quiet days. Several factors might contribute to the difference, such as the seasonal inclination of the dipole axis, the solar wind magnetic field, and the magnetospheric particle population. (auth)

41488 OSCILLATORY MOTION OF THE NOSE REGION OF THE MAGNETOPAUSE. Smit, Gjalt R. (European Space Research Inst., Rome). J. Geophys. Res., 73: 4990-3(Aug. 1, 1968).

In this note an approach is presented in which periodic perturbations in the solar wind are held responsible for driving the motion of the bow shock and magnetopause. It is shown that the motion of the nose region of the magnetopause can be described as a resonance motion with large amplitudes. (W.D.M.)

41489 DISCUSSION OF PAPER BY I. LERCHE, "VALIDITY OF THE HYDROMAGNETIC APPROACH IN DISCUSSING INSTABILITY OF THE MAGNETOSPHERIC BOUNDARY". Sen, Amiya K. (Columbia Univ., New York). J. Geophys. Res., 73: 5015-17 (Aug. 1, 1968).

Lerche (1966) raises several interesting questions regarding the applicability of hydromagnetic analysis of a Kelvin–Helmholtz configuration at the boundary between the solar wind and the magnetosphere. Though Lerche's points about the inadequacy and invalidity of the hydromagnetic analysis are penetrating and highly relevant, it is argued in this note that for the problem in question, these are not important. A reply by Lerche is included. (W.D.M.)

41490 SOME STUDIES ON THE IONOSPHERIC ABSORPTION AT WALTAIR. Rao, A. S. Mohana; Rao, B. Ramachandra (Andhra Univ., Waltair, India). J. Atmos. Terrest. Phys., 30: 1239-44(June 1968).

The results of absorption measurements made on frequencies 2.0, 2.5 and 3.0 Mc at Waltair (Geog. Lat. 17°43'N, Long. 83°18'E, Geomag. Lat. 7.4°N) during the period January 1963 to February 1965 are presented. The main aspects studied were (i) diurnal variation of absorption, (ii) the relative contributions of D- and E-region absorptions, (iii) sunspot variation of absorption, and (iv) effect of magnetic activity on absorption. The value of cos χ index n for the diurnal variation of absorption on 2.0 Mc was found to be 0.8. The relative contributions of D and E regions to 2.0-Mc absorption were estimated and it was found that the D-region contribution consists of two parts, one depending on the solar zenith angle and the other independent of that angle. The results of correlation studies between the absorption and magnetic activity are presented, and it is found that the effect of magnetic activity is more at higher levels of the absorbing stratum as compared with lower levels. (auth) (UK)

41491 COMPARISON OF ELECTRON DENSITY MEASUREMENTS IN THE LOWER IONOSPHERE BY A WAVE PROPAGATION AND AN RF CAPACITANCE PROBE METHOD. Holt, O.; Troeim, J.; Jespersen, M. (Norwegian Defence Research Establishment, Kjeller). J. Atmos. Terrest. Phys., 30: 1231-7(June 1968).

Measurements with an rf capacitance probe on a rocket showed strong field-aligned enhancements of ionization above 90-km altitude, during an auroral event. The thickness of the regions of increased electron density was 400 m. A detailed examination of Faraday rotation records at 7.8 and 15 MHz, during the same flight, showed that such structure can also be detected by a wave propagation experiment. (auth) (UK)

41492 WHISTLER MODE PROPAGATION IN THE IONOSPHERE IN THE PRESENCE OF A LONGITUDINAL STATIC ELECTRIC FIELD. Hsieh, H. C. (Univ. of Michigan, Ann Arbor). J. Atmos. Terrest. Phys., 30: 1219-29(June 1968).

The effect of a longitudinal electrostatic field on whistler mode propagation was studied in a region of the ionosphere where the influence of particle collisions and ion motion may be significant. The propagation in the following two cases was considered: with the E region in the neighborhood of 100 km height, and with the F region in the neighborhood of 250 km. It is shown that the presence of a weak static electric field E_0 tends to reduce the attenuation of the forward whistler mode when the magnetostatic field B_0 and the electrostatic field E_0 are in the same direction. Moreover, for a

sufficiently large value of E_0 the whistler mode may experience an amplification. On the other hand, when E_0 and B_0 are in opposite directions an increase in $|E_0|$ tends to increase the attenuation of the wave. The variations of the attenuation constant, phase constant, and the phase velocity of the whistler mode with the signal frequency and with the electrostatic field are also discussed in detail. (auth) (UK)

41493 THE ELECTRON DENSITY DISTRIBUTION IN THE D AND E REGIONS DURING DAYS OF ANOMALOUS RADIO WAVE ABSORPTION IN WINTER. Thomas, L. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 1211-17(June 1968).

A phase-integral method is used to compute the absorption and virtual heights of high and medium frequency waves reflected from postulated models of electron density with a height distribution of collision frequency appropriate to winter conditions. The results are compared with measurements of absorption and virtual heights made on a number of frequencies during February 1951, and the electron density distributions are progressively modified until the computed values agree with these measurements. In this way electron density distributions are deduced for normal days, on which the absorption was consistent with that measured during summer months, and for days showing anomalously large absorption. (auth) (UK)

41494 DETERMINATION OF VERTICAL DISTRIBUTIONS OF PLASMA TEMPERATURE AND COMPOSITION FROM SATELLITE MEASUREMENTS. Smith, P. A. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 1203-9 (June 1968).

A method is described for deriving from satellite data the vertical distributions of electron and ion temperatures and the concentration of each ion species in the ionosphere. Equations expressing diffusive equilibrium of the plasma are used. The data needed are obtained from topside sounder records, together with measurements of electron temperature and the relative ion concentrations at the spacecraft. (auth) (UK)

41495 A STUDY OF THE EQUATORIAL E REGION DURING EVENING TWILIGHT USING A LANGMUIR PROBE. Prakash, Satya; Subbaraya, B. H.; Gupta, S. P. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 30: 1193-1202 (June 1968).

Langmuir probe data obtained from a rocket flight during the evening twilight of March 12, 1967, from Thumba (India) near the magnetic equator are presented. An E2 layer was seen at 130 km during ascent and 136 km during descent. The electron temperatures in the layer were larger than below the layer by a factor of 2. The increased electron temperatures may be partially due to electric currents flowing in those regions. The decrease in the recombination coefficient with the increase in the electron temperature may at least partly be responsible for the enhanced ionization in these regions. Audio frequency fluctuations in the ambient ionized medium (ionospheric "noise") were recorded in the frequency range 880 Hz (±15%). The amplitude and the type of the signal spectrum were found to vary with height. The observed noise may be due to ion acoustic waves possibly produced by winds or electric fields. (auth)

41496 SOME RESULTS OF THE FR-1 SATELLITE EXPERIMENT ON THE VLF WAVE FIELD IN THE ZONE CLOSE TO THE TRANSMITTER. Aubry, M. L. (CNRS, France). J. Atmos. Terrest. Phys., 30: 1161-82(June 1968).

The FR-1 satellite experiment has provided much information concerning the characteristics and horizontal distribution at 750 km altitude of the vlf wave field radiated by a transmitter located at Sainte Assise (France). The study described is limited to the zone close to the transmitter, so only the mid latitude results are analyzed. After a general presentation of the measurements, the characteristics of the vlf field—namely, polarization and wave normal direction—are studied. It is shown that the wave normal direction is strongly dependent on the horizontal gradient of the electron density. With regard to the horizontal distribution of the vlf power at 750 km altitude, separate analysis of the average distribution, which can be calculated by using a simple model of the lower ionosphere, and the large- and small-scale spatial fluctuations around this average, is necessary. The large-scale spatial fluctuations (>200 km) are produced by interferences in the Earth–ionosphere waveguide. The small-scale spatial fluctuations (<100 km) are generally associated with F-region irregularities (spread-F) which produce scintillation or focusing. (auth)

41497 VLF EMISSIONS OBSERVED AT STATIONS CLOSE TO THE AURORAL ZONE AND AT STATIONS ON LOWER LATITUDES. Harang, L. (Norwegian Defence Research Establishment, Kjeller). J. Atmos. Terrest. Phys., 30: 1143-60(June 1968).

Vlf emissions on 8 kc were studied along a N–S chain of stations covering geomagnetic latitudes $\Phi = 75°$ to 50°. Two types of emission events are discussed: "polar" (or auroral) emissions close to the auroral zone occurring only at night-time, and "low-latitude" emissions having a different character and occurring at daytime. It is pointed out that the two classes of vlf emissions must be due to different classes of primary particle precipitation. The polar vlf is, in accordance with the satellite observations by Gurnett (1966), assumed to be due to intrusion of intense fluxes of soft electrons along the auroral zone. The low-latitude vlf is assumed to be due to influx of solar wind particles on the morning side of the rotating magnetosphere. Due to the coupling between the magnetosphere and the solar wind the asymmetric field of the magnetosphere may increase the pickup possibility of the solar particles on the morning side and produce the morning-side pulse of the low-latitude vlf. (auth) (UK)

41498 EFFECTS OF FIELD-ALIGNED IONOSPHERIC IRREGULARITIES ON SATELLITE SCINTILLATIONS. Parkin, I. A. (Univ. of Adelaide). J. Atmos. Terrest. Phys., 30: 1135-42(June 1968).

Observations of scintillations of radio signals from the satellites BEB and BEC made at Adelaide were analyzed to obtain information about the ionospheric irregularities which cause the scintillations. Observations of the radio diffraction pattern over the ground, made with three spaced receivers, indicate ionospheric irregularities aligned with their longer dimension along the Earth's magnetic field, and with axial ratios in the range 2–20. Observations of increases of scintillation depth when the direction of the radio ray is close to that of the magnetic field show effects in qualitative agreement with theory, but much larger in magnitude than would be expected on the basis of the above values of axial ratio. It is suggested that this result may indicate the presence of a new type of weakly ionized irregularities with very large values of axial ratio. However, further theoretical development appears to be necessary before a completely satisfactory model of such irregularities, consistent with all the observations, can be given. (auth) (UK)

41499 A REVIEW OF D-REGION PROCESSES IN NONPOLAR LATITUDES. Mitra, A. P. (Pennsylvania State Univ., University Park). J. Atmos. Terrest. Phys., 30: 1065-1114(June 1968).

The results of a re-examination of three major areas of D-region aeronomy are presented, namely: (a) the height distribution of nitric oxide, (b) the distribution of the effective recombination coefficient, and (c) the nature and distribution of negative ions. For nitric oxide, a previous estimate by the author from the solar cycle variation in the D-region electron density is supplemented by some new estimates from: (a) observed diurnal variation of the electron density and (b) recent measurements of ion composition. These, and a few other ionospheric estimates currently available, together with considerations of the photochemistry of nitric oxide, indicate that a distribution consistent with most of these estimates is of the form $n(NO) = 4 \times 10^{-1} \exp(-3700/T)\, n(O_2) + 5 \times 10^{-7}\, n(O)$. Values of the effective daytime loss coefficient $\psi = (1 + \lambda)d_{eff}$ were obtained from simultaneous use of information on the ionizing radiation and several electron density profiles derived from rocket and ground-based experiments. Examination of these, together with the many determinations on the effective recombination coefficient α' that have been made from the variations in electron density or absorption with the time of the day or during eclipses and solar flares, indicates that: (i) α' has a value around 2×10^{-7} cm^3/sec near 100 km, (ii) the dissociative recombination coefficient for NO^+ is about the same as that for O_2^+ (both being around 2×10^{-7} cm^3/sec), and (iii) negative ions are not important above 70 km during day or above 85 km during night. The observational results appear to agree with an empirical relationship of the form $\alpha' = 1.5 \times 10^{-7} + 2 \times 10^{-6}\, [n^2(O_2)/n_0^2(O_2)]$ where $n_0\,(O_2)$ corresponds to the reference level of 70 km. A new negative ion theory is presented, based on some recent laboratory measurements of Ferguson et al., (1967) in which it is shown that, while during the day the negative ions are predominantly O_2^-, there is a drastic change immediately after sunset. With the rapid decrease in the concentration of atomic oxygen and increase in that of NO_2, O_2^- is rapidly transformed into NO_2^- which becomes the predominant negative ion at night at all heights below about 70 km. (auth) (UK)

41500 RELATION BETWEEN THE S_q CURRENT SYSTEM AND THE DEFORMATION OF THE IONOSPHERIC E LAYER. Bencze, Pal; Wallner, Akos. Geofiz. Kozlem., 17: 55-62(1968). (In Hungarian).

The daily patterns of the geomagnetic horizontal component, observed between 1960 and 1962 on quiet days in the Geophysical Observatory of Nagycenk, and the f_0E values measured in Freiburg were used for investigation of the relation between the S_q current system and the deformation of the ionospheric E layer. It was established that the observed f_0E values—during the maximum of the daily pattern of the north-south H component—are much

smaller than the f_0E values calculated without consideration of the deformation effect of the vertical drift. It was concluded that the S_q current system lies at the altitude of the maximum electron density of the E layer and under it. On these days the apparent altitude of the maximum electron density is in the corresponding hours smaller than the average which supports the above conclusion. (tr-auth)

41501 RELATION BETWEEN THE AMPLITUDE AND RISE TIME OF THE SUDDEN COMMENCEMENT OF GEOMAGNETIC STORMS. Le Ming Triet. Geofiz. Kozlem., 17: 71-80(1968). (In Hungarian).

A possible development mechanism of magnetic storms was investigated on the basis of the magnetohydrodynamic theory. The relation between the amplitude ΔH and the rise time Δt of the sudden commencement magnetic storm is $\Delta H = C/\sqrt{\Delta t}$, where C is a constant, depending on the corpuscular current of the Sun. The data from the various observatories agree with this formula. It is shown that, between the distribution of the Aurora Polaris and the velocity of the corpuscular current of the Sun, there is a firm relation. (tr-auth)

Low-Temperature Physics

Refer also to abstracts 41707, 41717, and 41718.

41502 (COO-1098-17) ISOTOPE EFFECT IN ZINC AND ZIRCONIUM. Dillinger, J. R.; Fassnacht, R. E.; Jones, D. M. (Wisconsin Univ., Madison). [1966]. 5p. (CONF-660816-8). Dep. CFSTI.

From 10th International Conference on Low Temperature Physics, Moscow, USSR.

The three zinc specimens used had average isotopic masses of 63.96, 65.91, and 67.94. As received, the ratio of their resistivity at 4°K to that at 297°K was about $1/10$. A preliminary run showed that the superconducting-to-normal transition of one of them in the Earth's magnetic field was about 20 times as broad as that of a reasonably pure single crystal of natural zinc. To purify these samples, each was first sublimed two or three times in a horizontal pyrex tube connected to a vacuum system which maintained a pressure of about 3×10^{-6} torr. After distillation, each sample was annealed for over 24 hours at about 200°C in a He atmosphere. In final form, the samples were cylinders about 4 mm in diameter and $6\frac{1}{2}$ cm long. The ratios of their resistivities at 4°K to that at 297°K were 3.3×10^{-5} for ^{64}Zn, 2.7×10^{-5} for ^{66}Zn, and 3.6×10^{-5} for ^{68}Zn. Similar studies on zirconium (^{90}Zr, ^{92}Zr, and ^{94}Zr) indicated a zero-field transition temperature of about 0.56°K and suggested the absence of any isotope effect. These samples were prepared by condensation from the iodide vapor phase and were of moderate purity. (M.H.R.)

41503 (UCRL-71077) LARGE SUPERCONDUCTING MAGNETS. Henning, Carl D. (California Univ., Livermore. Lawrence Radiation Lab.). June 25, 1968. Contract W-7405-eng-48. 20p. (CONF-680622-1). Dep. CFSTI.

From 4th Annual Cryogenic Exposition and Technology Symposium, Chicago, Ill.

Materials available for use as type-II superconductors, their stabilization against electrodynamic transients, and the design and performance of large magnets are reviewed briefly. A tabulation of the characteristics of some specific large superconducting magnets is included. (26 references) (A.G.W.)

41504 INFLUENCE OF ALUMINUM ADMIXTURE ON THE SUPERCONDUCTING PROPERTIES OF TIN. Sulkowski, C.; Mazur, J. (Inst. of Low Temperatures and Structural Investigations, Wroclaw). Acta Phys. Pol., 33: 827-30(May 1968).

The variation of the superconducting properties of tin with aluminum impurity concentration has been investigated. The measure of purity has been determined from the ratio $R_{300°K}/R_{4.2°K}$. It has been found that the transition temperature, the critical current, and the critical magnetic field depend on impurity concentration. The amount of aluminum soluble in tin does not exceed 0.7 at. %. (auth)

41505 CRITICAL FIELDS, $H_{c1}(T)$ AND $H_{c3}(T)$, IN STRONG-COUPLING SUPERCONDUCTORS. Yorke, Ellen Ruth Davis. College Park, Md., Univ. of Maryland, 1967. 88p.

Thesis.

The Ginsburg-Landau equations are developed for a superconducting system with strongly retarded electron-phonon interactions. The resultant equations are then solved for two choices of phonon spectrum, the first being a simple Einstein one and the second being that of two Lorentzians. For comparison with experiment, parameters are chosen appropriate to the strong coupling element, Pb. Solutions, with the aid of a computer, are obtained for the critical field $H_{c2}(T)$ close to the critical temperature, T_c, for both the clean and dirty cases. Results are then compared with experiment. An automatic corollary of our G-L equations is that the ratio of the critical field, $H_{c3}(T)$, associated with nucleation in a surface layer, to $H_{c2}(T)$ is 1.7, the same as for weak coupling superconductors. (Diss. Abstr.)

41506 ON THE "THREE-PARAMETER" FORM OF PHENOMENOLOGICAL THEORY OF SUPERFLUIDITY. Mamaladze, Yu. G. (Inst. of Theoretical Physics, Moscow. Inst. of Physics, Tbilisi, USSR). Phys. Lett., 27A: 322-3(July 15, 1968).

The third coefficient in the expansion of the free energy of He II is shown to be undistinguishable from zero using experimental data present just to day. (auth)

41507 LATTICE SOFTENING AND STIFFENING OF SINGLE-CRYSTAL NIOBIUM STANNIDE AT LOW TEMPERATURES. Rehwald, W. (Radio Corporation of America, Ltd., Zurich). Phys. Lett., 27A: 287-8(July 15, 1968).

In addition to the softening of the lattice, a lattice stiffening has been observed at temperatures below the transformation. This is in accordance with theory, which predicts that the influence of the d electrons on the elastic behavior vanishes at T = 0. (auth)

41508 ENERGY-GAP ANISOTROPY AND THE SPECIFIC HEAT OF SUPERCONDUCTING Al-Mg ALLOYS. Cheeke, J. D. N.; Ducla-Soares, E. (CNRS, Grenoble, France). Phys. Lett., 27A: 264-5(July 15, 1968).

The specific heat of dilute Al-Mg alloys was measured between 0.20 and 0.60°K. The deduced anisotropy $\langle a^2 \rangle \approx 0.010$ is consistent with previous work and the variation with purity is in qualitative agreement with Clem's theory. (auth)

41509 LOCALIZED MAGNETIC STATES IN TWO-BAND SUPERCONDUCTORS. Marinchuk, M. E.; Moskalenko, V. A. (Inst. of Mathematics, Kishinev). Phys. Lett., 27A: 266-7 (July 15, 1968).

The localization of magnetic moments in two-band superconductors is investigated. The cases, when superconductivity furthers the localization of the magnetic moments, are shown. (auth)

41510 PHENOMENOLOGICAL THEORY FOR LIQUID HELIUM NEAR THE λ TRANSITION. Wong, V. K. (Ohio State Univ., Columbus). Phys. Lett., 27A: 269-70(July 15, 1968).

Microscopic and scaling-law considerations are used to motivate a new form of the Landau phenomenological theory of second-order transitions as applied to the λ transition of liquid helium. (auth)

41511 THE λ-POINT OF ^{4}He IN A ROTATING ANNULUS. Veith, W.; Pobell, F. (Technische Hochschule, Munich). Phys. Lett., 27A: 254-5(July 15, 1968).

The λ-point of liquid ^{4}He in an annulus has been found to be independent of rotation to within $\Delta T_\lambda = 1 \times 10^{-6}$°K up to $\omega = 31$ sec^{-1} in agreement with theory but opposite to a recent experiment. (auth)

41512 PERSISTENT CURRENTS IN A SUPERCONDUCTOR WITH PARAMAGNETIC IMPURITIES. Kalpagiu, M. K.; Moskalenko, V. A. (Moldavian Academy of Sciences, Kishinev). Phys. Lett., 27A: 295(July 15, 1968).

The effect of paramagnetic impurity scattering on a uniform current in a one-band superconductor is investigated. Expressions are given and discussed for the maximal current density, the critical concentration and the gap in energy spectrum. (auth)

41513 NERNST EFFECT IN SUPERCONDUCTING NIOBIUM. Huebener, R. P. (Kernforschungsanlage, Juelich, Ger. Argonne National Lab., Ill.); Seher, A. Solid State Commun., 6: 403-6 (June 1968).

The Nernst voltage in the mixed state of superconducting niobium was measured as a function of the magnetic field. The samples were high purity Nb foils of 18-μ thickness. Using Nernst probes at more than one location of the same specimen, details of the flux flow caused by the temperature gradient could be determined. For a fixed section of the specimen the balance between incoming and outgoing flux could be domonstrated directly. (auth) (UK)

41514 NIOBIUM AND 75 PERCENT ZIRCONIUM SUPERCONDUCTING MAGNET FOR 85 kG. Goncharov, I. N. (Inst. of Nuclear Studies, Dubna, USSR). Cryogenics, 8: 158-61(June 1968).

A magnet is described consisting of a combination of a superconducting solenoid and a pair of pole pieces placed inside. The solenoid, with inner diameter 18, outer diameter 75, and length 74 mm is made of Nb + 75% Zr wire, was heat treated at 500°C for 1 h. At 4.2°K the field obtained was 53 kG (I_c = 42.5 A) and at 4.05°K was 57.5 kG (I_c = 46 A). The solenoid shows high stability and almost complete absence of degradation effects of the critical current. The ferromagnetic inserts make it possible to increase the field in a 1.1 mm gap to 85 kG and the critical current of the solenoid is then increased somewhat. (auth) (UK)

41515 A $^3He/^4He$ DILUTION REFRIGERATOR FOR MOESSBAUER EXPERIMENTS AT VERY LOW TEMPERATURES. Ehnholm, G. J.; Katila, T. E.; Lounasmaa, O. V.; Reivari, P. (Technical Univ. of Helsinki). Cryogenics, 8: 136-42(June 1968).

A versatile cryostat for Moessbauer-effect research at temperatures as low as 0.03°K is described. For cooling, the apparatus uses the $^3He/^4He$ dilution refrigerator principle, which is well suited to investigations of this type. Both constructional and operational features of the cryostat are described, and some examples of measured spectra are given. (auth)

41516 SUPERCONDUCTING DEVICE FOR ENLARGING MAGNETIC FLUX CHANGES. Eckert, D.; Lange, F. (Institut fuer Tieftemperaturphysik, Dresden). Cryogenics, 8: 168-70(June 1968).

A superconducting device was used as a flux transformer to allow the amplified transformation of the magnetic flux change to another point where it could be measured, for example, with solid-state probes. Essentially, the flux transformer consists of a closed superconducting circuit comprising two coils with coil-turn numbers n_1 and n_2, inductances L_1 and L_2, and a connection line with inductance L_3. The magnetic flux ϕ to be measured is made to pass coil 1. The relationship derived is $\phi_2 = n_1/n_2 \cdot (L_2/L_1 + L_3 + L_2)\phi$, where ϕ_2 is the magnetic flux generated in coil 2, so that amplification of the flux ϕ is possible if $n_1/n_2 > (L_1 + L_2 + L_3)/L_2$. (UK)

41517 MEASUREMENT OF MAGNETOSTRICTION AT LOW TEMPERATURES USING A SUPERCONDUCTING SOLENOID. Sokolov, V. K. (Moscow State Univ.). Cryogenics, 8: 149-51 (June 1968).

An apparatus is described for measuring the magnetostriction of ferro- and ferrimagnetics in the temperature range 2 to 120°K, using the differential capacity principle. The sensitivity is $\Delta l/l = 5 \times 10^{-8}$. A superconducting solenoid is used to magnetize the specimens, attaining fields up to 30 kOe. (auth) (UK)

41518 QUANTUM INTERFERENCE IN THE RESISTIVE STATE OF SUPERCONDUCTORS. Dmitrenko, I. M.; Bondarenko, S. I. (Physico-Technical Inst. of Low Temperatures, Moscow). JETP Lett. (USSR) (Engl. Transl.), 7: 241-3(May 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 308-11(May 5, 1968).

Using superconducting interferometers constructed by Clarke's method, a time-invariant voltage was observed oscillating in the magnetic field in the absence of transport current with the same periodicity as the voltage oscillations in the magnetic field in the presence of transport current. (TSS)

41519 RESISTIVITY AND HALL EFFECT IN SUPERCONDUCTING Nb. Fiory, A. T.; Serin, B. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 21: 359-61(Aug. 5, 1968).

The resistive electric field and the Hall field were measured in pure Nb in the mixed state as a function of magnetic field at high current densities and at several temperatures. An analysis of vortex motion in the presence of a pinning force shows that in the limit of high current density the differential resistivities become independent of pinning force. It is found that the flux-flow resistivity is proportional to B/H_{c2} and the Hall resistivity equals RB. It follows that the Hall tangent in the mixed state is constant and equal to its value at H_{c2}. (auth)

41520 FLUX JUMPING PHENOMENA IN SPUTTERED CYLINDRICAL NIOBIUM FILMS. Hlawiczka, P.; Ross, J. M. (Univ. of Glasgow). J. Phys., D, 1: 995-1004(Aug. 1968).

Measurements of the critical temperature and resistance ratio of cylindrical niobium films, prepared by getter sputtering, indicated that their purity was high. Magnetic measurements on the superconducting films showed that flux penetrated to the bore of the cylinder, either in the form of regular jumps or continuously, in a manner resulting in regular hysteresis. The variation of the magnitude of the jumps with applied field and temperature is reported; the magnitude was also found to be proportional to the square root of film thickness. The latter result is also obtained from a thermodynamic energy-balance calculation, but predictions of the flux jump height as a function of the applied field and temperature yield only partial agreement with experiment. (auth) (UK)

41521 LOSSES IN SUPERCONDUCTING MAGNET. Sakamoto, Nobuyoshi; Irie, Fujio (Kyushu Univ., Japan). Kyushu Diagaku Kogaku Shuho, 40: 791-7(Nov. 1967). (In Japanese).

The formula, proposed previously by the authors, expresses F_p in a generalized manner, and includes F_1, F_p, and F_v, and the continuity of flow of magnetic-induction lines. With this formula, the loss in a superconducting magnet is calculated when the loss by F_v is sufficiently small. Further, the loss is measured for a small superconducting magnet constructed in trial. A comparison is made between experiment and calculation. (NSA of Japan)

41522 SURFACE SUPERCONDUCTIVITY IN TANTALUM. Smith, Frank T. J.; Gatos, Harry C. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 3793-7(July 1968).

The superconducting behavior of tantalum wire in a longitudinal magnetic field was studied by means of electrical-resistance measurements. The results were compared with the predictions of the Saint-James and DeGennes theory. Under certain conditions the critical field for surface superconductivity as well as a higher critical field were observed. The persistence of superconductivity in fields higher than the critical field for surface superconductivity was attributed to the presence of clusters of interstitial impurity atoms in the material. The effects of strain on these critical fields were also explained on the same basis. (auth)

41523 MAGNETIZATION OF SUPERCONDUCTING Cu–Pb ALLOYS. Livingston, J. D. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys., 39: 3836-43(July 1968).

Magnetization curves have been measured on as-cast and annealed Cu–Pb alloys and correlated with microstructural observations. Magnetic hysteresis and trapped flux are observed and related to a multiply connected lead network. Critical fields are lower than for bulk lead and are lowest for the as-cast monotectic alloy, where the lead is most finely dispersed. Both a surface energy effect and the proximity effect contribute to this result. Proximity-effect calculations are extended to the cases of rodlike and spherical superconducting particles and are compared with experiment. (auth)

41524 VORTEX-RING FORMATION BY NEGATIVE IONS IN He II UNDER PRESSURE. Neeper, D. A. (Univ. of Chicago). Phys. Rev. Lett., 21: 274-5(July 29, 1968).

It was previously shown that at temperatures ≥ 0.36°K and pressures >12 atm negative ions in He II could be accelerated until they emitted rotons at velocities of about 50 m/sec. One finds that at temperatures ≤ 0.3°K negative ions produce only vortex rings at pressures up to 16 atm. (auth)

41525 INDUCED MOTION OF MAGNETIC FLUX LINE IN TWO ADJACENT SUPERCONDUCTING FILMS. Kusayanagi, Eiichirou; Yamafuji, Kaoru (Kyushu Univ., Japan). Kyushu Daigaku Kogaku Shuho, 40: 819-22(Nov. 1967). (In Japanese).

In the experiment performed, the occurrence of a magnetic-flux motion in region II was confirmed; the experiment on magnetic-flux motion is usually for region I only. To observe in detail the motion in an intermediate state, the magnetic field in a stationary case is required. The situation becomes more complicated because of the difficulty in obtaining pure samples and the susceptibility of the intermediate state to the shape effect. With data on highly pure samples, the pinning to the magnetic flux can be made clear. (NSA of Japan)

41526 JOSEPHSON-EFFECT FAR-INFRARED DETECTOR. Grimes, C. C.; Richards, P. L.; Shapiro, Sidney (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 39: 3905-12 (July 1968).

Superconducting point contacts, bridges, and tunnel junctions are all capable of carrying a zero-voltage current; i.e., no voltage appears across the device until the current exceeds a finite critical value. The critical value of the zero-voltage current is changed when microwave radiation is incident on such a junction. Thus such a device can be used as a detector of radiation. Experiments have been carried out demonstrating that this detection mechanism extends well into the far-infrared, is highly sensitive, and has inherently high speed. Junctions were formed by pressing together the ends of two superconducting wires, one of which was flat, the other pointed. The spectral response of such point-contact junctions was studied by using them as detectors in a far-infrared Fourier transform spectrometer in which they were irradiated by broadband, incoherent radiation. The response of Nb–Nb junctions was found to extend to frequencies above 40 cm^{-1} ($\lambda < 250$ μ), i.e., to about twice the superconducting energy gap. Measurements using a klystron source at 2.5 cm^{-1} ($\lambda = 4$ mm) yielded a value of 5×10^{-13} W for the noise equivalent power in a one-cycle bandwidth and showed the junction detector could follow a pulsed signal that had a risetime of 10 nsec. Preliminary experiments using a monochromatic laser source at 32.2 cm^{-1} showed the appearance of constant-voltage steps in the voltage–current characteristic of the junction, as is well known at microwave frequencies. These experiments demonstrate the existence of the Josephson effect at frequencies up to and beyond the superconducting energy gap, and show that over this range of frequencies, Josephson junction detectors exhibit both high sensitivity and high speed when compared with other helium-temperature far-infrared detectors. (auth)

41527 MAXIMUM COMPLETELY STABILIZED CURRENT DENSITY IN COMPOSITE SUPERCONDUCTOR. Ihara, Seijiro;

Kaiho, Katsuyuki (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys., 7: 959(Aug. 1968).

The maximum current density which does not induce the propagation of normal phase, and thus the maximum completely stabilized current density, was measured in a 0- to 30-kG magnetic field for model pieces of Nb–Zr composite superconductor wire. (TSS)

41528 SUPERCONDUCTING-DYNAMO PROPERTIES AND APPLICATIONS. van Houwelingen, D.; Volger, J. Philips Res. Rep., 23: 249-69(June 1968).

Superconducting dynamos, in particular those fitted with niobium foil, have been studied theoretically and experimentally. The agreement between the simplified theory given and the experiments is fairly good. The dynamo voltage is proportional to the velocity of the flux-containing normal spot, created in the niobium foil, up to 4 m/s and decreases linearly with the generated current. The power dissipated in the niobium foil consists of two parts. The first part, caused by eddy currents in the normal spot, is proportional to the square of the amount of rotating flux per unit of time. The second part is the local magnetic-field energy in the superconducting foil destroyed per unit of time by the (continuous) switching action in the superconducting foil, and is proportional to the square of the generated current. Methods of reducing these losses are described. A description of some of the working models of the superconducting dynamo is given. To show the possibilities of the superconducting dynamo some applications have been tried out. (auth)

41529 TRANSFORMATION OF GORKOV'S EQUATION FOR TYPE II SUPERCONDUCTORS INTO TRANSPORT-LIKE EQUATIONS. Eilenberger, Gert (Univ., Cologne). Z. Phys., 214: 195-213(1968).

The stationary behavior of Type-II superconductors is completely described by Gorkov's equations for a set of four Green's functions, supplemented by two self-consistency equations for gap parameter $\Delta(r)$ and vector potential $A(r)$. Expanding all quantities as usual at the Fermi surface and averaging over impurity positions, this set of equations is transformed into a simpler set for integrated Green's functions (which still contain much more information than is needed in most cases). The resulting equations, when linearized, yield essentially Lüders' transport equation for de Gennes' correlation function. The full equations contain all the known results and provide a promising starting point for numerical calculations. The thermodynamic potential is constructed as a functional of the integrated Green's functions and the mean fields Δ and A and a variational principle is formulated which uses this functional. Finally, paramagnetic scatters are included (in Born approximation) as an example for possible generalizations of the new equations. (auth)

41530 SUPERCONDUCTING MAGNETS. Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet., MAG-4: 99-107(June 1968).

Although small superconducting magnets have been in regular use in many laboratories for several years, it is only recently that the technical difficulties preventing the use of superconductors in large magnet systems have been overcome. A better understanding of the transient thermal and magnetic behavior of such devices has led to various methods of reducing or eliminating the degradation effects present in earlier magnets. The use of large amounts of very high conductivity normal metal in conjunction with the superconductor has resulted in "stabilized" magnets whose behavior is completely predictable and which will not quench except under unusual conditions. Other techniques have been developed to improve "unstable" magnets so that very high field coils can be constructed. These developments are dramatically altering the equipment used in high-energy physics and controlled thermonuclear experiments, and their effect on other areas of technology is already beginning to be felt. (auth)

41531 ALLOY STRUCTURE STUDIES LEAD TO NEW SUPERCONDUCTOR. Chem. Rundsch. Solothurn, 37: 685(Sept. 13, 1967).

X-ray-diffraction studies made on 18 alloys to determine the degree of long-range order are described. A previously unreported transition to a superconducting state was found to occur in the Cr–Os alloy at 4.03°K. (TSS)

41532 MEASUREMENT OF THE DENSITY MAXIMUM ^{4}He AT SATURATED VAPOR PRESSURE. Barmatz, M.; Rudnick, I. (Univ. of California, Los Angeles). Phys. Rev., 173: 275-7 (Sept. 5, 1968).

The temperature of the density maximum of liquid ^{4}He at saturated vapor pressure was found to be $T_\lambda + (6.28 \pm 0.1) \times 10^{-6}$°K in an experiment based on the presence of the thermal anomaly which accompanies the change in the direction of convective currents when the density passes through its maximum value. This result, with the known specific heat and a Pippard–Buckingham–Fairbank relation, yields 2.74 ± 0.08 J $g^{-1}(°K)^{-2}$ for $(dS/dT)_\lambda$. (auth)

41533 PHASE SEPARATION IN ^{3}He–^{4}He MIXTURES OBSERVED WITH SLOW NEUTRONS. Schermer, R. I.; Passell, L.; Rorer, D. C. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 173: 277-84(Sept. 5, 1968).

A method of studying phase separation in ^{3}He–^{4}He mixtures is described in which thermal neutrons are used to determine the ^{3}He number density in each phase. Results of measurements made over the temperature range 0.04 to 0.85°K are presented and compared with those obtained by other methods. Extrapolation of the measurements made below 0.15°K indicates that the limiting solubility of ^{3}He in ^{4}He at T = 0°K is 6.84 ± 0.06%. The second phase at low temperatures is found to be pure ^{3}He within the 1% accuracy of the measurement. (auth)

41534 PHONON–QUASIPARTICLE INTERACTIONS IN DILUTE SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. III. ATTENUATION OF FIRST SOUND ABOVE 0.2°K. Baym, Gordon; Saam, W. F.; Ebner, C. (Univ. of Illinois, Urbana). Phys. Rev., 173: 306-13(Sept. 5, 1968).

Utilizing a previously developed phonon Boltzmann equation, an earlier calculation of first sound attenuation in dilute solutions of ^{3}He in superfluid ^{4}He is extended to higher temperatures. The present calculation takes into account thermal phonon–^{3}He scattering and is valid up to about 0.7°K. The results are in good overall agreement with experiment. (auth)

41535 SUPERCONDUCTIVITY IN SCIENCE AND TECHNOLOGY. Proceedings of Conference Held at University of Chicago, May 23–24, 1966. Cohen, Morrel H. (ed.). Chicago, University of Chicago Press, 1968. 169p. $5.95. (CONF-660576).

Seven chapters by different authors treat the following subjects in a general manner: theory of superconductivity, superconductive tunneling, superconducting materials, instruments that exploit the macroscopic quantal character of superconductivity, the feasibility of superconducting power transmission lines, the outlook for superconductors in technology, and economic aspects of superconductivity. (A.G.W.)

41536 ELECTRON–PHONON INTERACTION AND SUPERCONDUCTIVITY IN NON-MAGNETIC DILUTE ALLOYS. Kawamura, Kiyoshi; Kuroda, Yoshihiro (Tokyo Univ.). J. Phys. Soc. Jap., 25: 383-90(Aug. 1968). (ISSP-A-288).

Effect of electron–phonon interaction on the change of the low temperature specific heat and superconducting transition temperature due to the nonmagnetic impurities described by the Anderson model is discussed. The former suffers no modification but, in the expression of the latter obtained by Ratto and Blandin, the density of states of s electrons must be affected in the same way as that of specific heat of the pure metal in the normal phase. (auth)

41537 THEORETICAL PROBLEMS IN SUPERCONDUCTIVITY. Froehlich, H. (Univ. of Liverpool). Phys. Bull. (London), 19: 209-12(July 1968).

Some of the unsolved problems in superconductivity are indicated, after an introductory review of the subject. These include problems of method, problems of interaction, and long-range phase correlations. (UK)

Plasma and Thermonuclear Physics

Confinement and Heating of Plasma

41538 (NP-tr-1672) EXPERIMENTAL INVESTIGATION OF THE EFFECT OF SPACE CHARGE ON THE MOTION OF ELECTRONS IN A MAGNETIC MIRROR TRAP WITH EXTERNAL INJECTION. Ponomarenko, V. G.; Trainin, L. Ya.; Yurchenko, V. I.; Yasnetskii, A. N. (Akademiya Nauk SSSR, Novosibirsk, Institut Yadernoi Fiziki). Translated for Culham Lab., Abingdon, Eng., from a report. 6p. (CTO-492). Dep. CFSTI. UK.

It is shown that the space charge from a beam of electrons emitted from a gun leads to the capture in the trap of electrons having magnetic moments which are larger than the moments calculated from adiabatic theory. (auth)

41539 (NP-tr-1677) ESTIMATE OF THE EFFECT OF IONIZATION LOSSES ON ELECTRON CONTAINMENT TIME IN MAGNETIC MIRROR TRAPS. Ponomarenko, V. G.; Trainin, L. Ya.; Yurchenko, V. I.; Yasnetskii, A. N. (Akademiya Nauk SSSR, Novosibirsk, Institut Yadernoi Fiziki). Translated for Culham Lab., Abingdon, Eng., from Report No. 154. 8p. (CTO-506). Dep. CFSTI. UK.

The influence of ionization losses on the time dependence of the electron currents leaving the working volume of the trap is analyzed. Relationships are calculated which indicate that the complete loss of collector current is attributable to the circumstance that during the time τ_p the electrons lose practically all their energy by inelastic scattering on the residual gas. The agreement between the experimental data and calculated results is reasonably satisfactory. (auth)

41540 (UCRL-70932) PLASMA CONFINEMENT IN THE LEVITRON. Anderson, O. A.; Birdsall, D. H.; Hartman, C. W.; Lauer, E. J.; Furth, H. P. (California Univ., Livermore. Lawrence Radiation Lab.). June 19, 1968. Contract W-7405-eng-48. 26p. (CONF-680805-8). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

Confinement of gun-injected plasma and anisotropic hot electron plasma is investigated in the Levitron. Field configurations are employed which have strong shear ($L_s/r_p \approx 0.1$ to 1), reversible gradient in average B, and a local minimum |B| mirror region of the Kadomtsev type embedded in the closed toroidal flux surfaces. (TSS)

41541 (UCRL-70933) THEORETICAL AND EXPERIMENTAL RESULTS ON THE TRAPPING AND BEHAVIOR OF THE E-LAYER IN THE ASTRON. Beal, J. W.; Brettschneider, M.; Christofilos, N. C.; Hester, R. E.; Lamb, W. A. S.; Sherwood, W. A.; Spoerlein, R. L.; Weiss, P. B.; Wright, R. E. (California Univ., Livermore. Lawrence Radiation Lab.). June 20, 1968. Contract W-7405-eng-48. 19p. (CONF-680805-9). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

The injection of 300A of 3.8-MeV electrons into the Astron solenoid resulted in the trapping of sufficient electrons to form an E layer with strong diamagnetic effect. Low-frequency stable precessional oscillations of the E layer were observed during the initial operation of the Astron facility. The precession frequency ω_p is the difference between the gyrofrequency (ω_c) and betatron frequency ω_c $(1-n/2)$ of the E layer where $n = (R\partial B/B\partial r)$ of the confining mirror field. The magnetic field of the E layer generates image currents in the walls of the tank, which in turn generate a field with positive gradient which is proportional to the loading factor (ζ) of the E layer (ζ is defined as the ratio of the self-field of the E layer to the external confining field B_0). When the loading factor ζ exceeds a certain threshold (ζ_c) the sense of the precession is reversed, and theory predicts that the motion is stable in agreement with the experiment. The field generated by an E layer of moderate thickness was calculated. The image currents, the positive field index, and the threshold value of the loading factor ζ were calculated as a function of the tank wall and the E layer radius. The image currents provide a minimum-B field which tends to center the E layer about the axis of symmetry of the tank. The experimentally observed value of ζ exceeds the calculated threshold ζ_c but as electrons are lost by scattering in the residual gas the loading factor is gradually diminished. When ζ reaches the calculated value of ζ_c the net value of the field index becomes zero, an integral resonance occurs, and theory predicts that the E layer will be "dumped" promptly. The "dump" is experimentally observed at the calculated value of ζ_c. (auth)

41542 TURBULENT HEATING OF PLASMA IN A MIRROR. Jensen, T. H.; Scott, F. R. (Gulf General Atomic, Inc., San Diego, Calif.). Phys. Fluids, 11: 1809-19(Aug. 1968).

By the discharge of condensers, a current is driven axially through a plasma column located in a mirror field. The maximum value of the current is typically 5000 A and the frequency typically 1 Mc/sec. It is found that under a variety of circumstances, 3 to 4% of the energy initially stored in condensers is transferred to perpendicular energy of the plasma. A substantial part of the energy is transferred to ions. The ion energy spectrum has been measured in one case and within experimental error found Maxwellian with a temperature close to 500 eV. Measurements of x rays emitted when a tantalum target is placed in the plasma show that very few high-energy electrons (>5 keV) are present except while the axial current flows. It is found that the energy transferred to the plasma is proportional to the square of the maximum current; this suggests that efficiencies higher than 4% may be obtained. (auth)

41543 DIRECT MEASUREMENT OF NONCLASSICAL PARTICLE LOSSES IN A LINEAR QUADRUPOLE. Palladino, R. W.; Yoshikawa, S. (Princeton Univ., N. J.). Phys. Fluids, 11: 1820-2(Aug. 1968).

In a linear quadrupole plasma containment device, lacking internal supports for the current conductors, the flux of charged particles from the main plasma volume is measured directly. With rf-produced plasmas (n_e between 10^{10} to 10^{12} cm^{-3}, $T_e \sim$ 10 eV, $T_i < 1$ eV), the end losses are only a small fraction of the total losses. Most of the plasma is lost outwards in a direction perpendicular to the current conductors (radial loss). With gun-injected plasmas, the radial loss is usually smaller than the end loss but is still nonclassical. (auth)

Diagnostics of Plasma

41544 (INR-859) THEORY OF POPULATION OF EXCITED LEVELS OF ATOMS AND IONS AND ITS APPLICATION TO DETERMINATION OF ELECTRON TEMPERATURE AND DENSITY FROM RELATIVE LINE INTENSITIES OF THE IONS C IV, N V, AND O VI. Suckewer, Szymon (Institute of Nuclear Research, Warsaw (Poland)). 1967. 61p. Dep.

The theory of population of excited levels for atoms and ions is given for stationary, nonthermal plasmas. Simplified expressions are obtained from which populations of the levels 2P, 3P, and 3D were determined for the ions C IV N V, and O VI. It is shown that the populations obtained by this method are in a very good agreement with the populations determined directly from the balance of excitation and de-excitation processes. The plots are given, which enable the determination of electron density and temperature from relative intensities of three chosen lines from a given ion. (auth)

41545 (LA-tr-68-23) HOLOGRAPHIC DIAGNOSTICS OF A PLASMA. Zaidel', A. N.; Ostrovskaia, G. V.; Ostrovskii, Iu. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report FTI-085. 30p. Dep. CFSTI.

An attempt was made to evaluate the new possibilities which holography gives for plasma diagnostics, and the results obtained up to the present time are systematized. (M.O.W.)

41546 (NP-tr-1679) HOLOGRAPHY IN PLASMA DIAGNOSTICS. Zaidel, Z. N.; Ostrovskaya, G. V.; Ostrovskii, Yu. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated for Culham Lab., Abingdon, Eng., from Report No. 85. 27p. (CTO-508). Dep. CFSTI. UK.

New possibilities presented by holography in plasma diagnostics are discussed. The results are mainly of an illustrative character. (M.O.W.)

41547 (TID-24566) PLASMA IMPEDANCE ELEMENT IN AN ACTIVE FABRY-PEROT MICROWAVE RESONATOR. Ajmera, R. C.; Lashinsky, H. (Maryland Univ., College Park). May 1968. Contract AT(40-1)-3405-3. 11p. (BN-551). Dep. CFSTI.

Experiments are described in which a plasma is used as an impedance element in an active Fabry-Perot microwave resonator. The system contains a feedback loop with a broadband amplifier (traveling-wave tube) that introduces positive gain into the system. The availability of positive gain offers a number of new and interesting features, one being the use of an active system in plasma-diagnostics applications. The use of a plasma as a power and frequency-determining impedance element in an active system also appears to be a possibility. (M.O.W.)

41548 MEASUREMENT OF THE RECOMBINATION COEFFICIENT α IN THE DENSE ARGON PLASMA. Aleksandrov, V. Ya.; Gurevich, D. B.; Podmoshenskii, I. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 178-81(Mar. 1968).

Translated from Opt. Spektrosk., 24: 342-7(Mar. 1968).

In order to measure the recombination coefficient at high electron concentrations, a non-equilibrium Ar plasma was obtained by superposing a 5×10^{-8} second pulsed electric field on a steady arc discharge. The state of the plasma is analyzed and its parameters are determined. At an electron temperature of $T_e = 9000°K$ and an electron concentration of $N_e = 2 \times 10^{16}$ cm^{-3}, the recombination coefficient α is found to be $\alpha = 4 \times 10^{-11}$ cm^3 sec^{-1}. (auth)

41549 DETERMINATION OF THE TEMPERATURE OF IONS AND NEUTRAL ATOMS AND THE CONCENTRATION OF ELECTRONS IN A SOURCE OF MULTIPLY CHARGED IONS. Romanov, N. P.; Pasyuk, A. S. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 176-8(Mar. 1968).

Translated from Opt. Spektrosk., 24: 337-41(Mar. 1968).

The characteristics of a low-pressure arc discharge with electron oscillation in a magnetic field in a mixture of helium and hydrogen were investigated. The temperatures of the atoms and ions were determined for various operating regimes by means of the Doppler broadening of the He and N lines, and the electron concentration according to the Stark broadening of the line H_β. The sputtering of cathode material turned out to have an effect upon the discharge characteristics. (auth)

41550 CONVERGENCE OF THE TWO-COMPONENT PLASMA CORRELATION FUNCTION. Lee, Y. C.; Lin, D. L.; Wu, Ta-you (State Univ. of New York, Buffalo). Phys. Rev., 172: 145-8(1968).

It has been suggested that the divergence of the two-component plasma correlation function at small interparticle distances may be removed by taking quantum corrections to the classical result in a certain manner. It is shown that this approach is not possible in general. A completely quantum-mechanical treatment is given instead, and an explicit convergent expression for the radial distribution function at small r is obtained. Also discussed is the fact that there does not seem to exist any simple interpolation formula that bridges the classical and the quantum-mechanical results for r in the region of thermal de Broglie wavelengths. (auth)

41551 NUMERICAL METHOD FOR OBTAINING INTERNAL EMISSION COEFFICIENTS FROM EXTERNALLY MEASURED SPECTRAL INTENSITIES OF ASYMMETRICAL PLASMAS. Olsen, H. N. (Plasma Sciences Labs., Inc., Van Nuys, Calif.); Maldonado, C. D.; Duckworth, G. D. J. Quant. Spectrosc. Radiative Transfer, 8: 1419-30(July 1968).

A numerical method is presented for inverting the integral equation which relates the emitted spectral intensity to the internal emission coefficient for optically thin plasmas. The method is applicable to both symmetrical and asymmetrical plasmas, with no required orientation of the source with respect to the laboratory coordinate system. The validity of the series representation of the emission coefficient was checked by means of a hypothetical model consisting of a source whose emission coefficient was taken as an asymmetrically displaced gaussian function. The method was further tested by applying it to the well-known symmetrical argon arc also asymmetrically displaced with respect to the origin of the laboratory coordinate system. The fully developed method was used as a practical tool for investigating the internal properties of a generally asymmetrical experimental plasma distorted by an external magnetic field. (auth) (UK)

41552 NEW METHOD OF DETERMINING THE ELECTRON DENSITY AND COLLISION FREQUENCY IN PLASMA. Bhagavat, G. K.; Nandedkar, D. P. (Indian Inst. of Tech., Bombay). Int. J. Electron., 24: 79-87(Jan. 1968).

An analysis of the propagation phase constant β_p of a T.E.M. wave in plasma is made, introducing a new factor ω_β that is proportional to the elastic restoring force on an electron in the space charge region under the influence of the electric field. From the experimental determination of β_p in the anomalous dispersion region the electron density N_e and the collision frequency ν are obtained. (auth) (UK)

41553 LOCAL THERMODYNAMIC EQUILIBRIUM IN AN RF ARGON PLASMA. Scholz, P. D.; Anderson, T. P. (Univ. of Iowa, Iowa City). J. Quant. Spectrosc. Radiative Transfer, 8: 1411-18 (July 1968).

The existence of local thermodynamic equilibrium in the center half of an inductively sustained rf argon plasma was investigated using emission spectroscopy as the diagnostic tool. The experiment was conducted with a fixed oscillator frequency of 4.2 MHz, a fixed plate input power of 2.0 kW, a constant average gas velocity of 9.0 cm/sec, and pressure levels of 0.01, 0.1, 0.5, and 1.0 atm. Four emission lines and the continuum centered at three different wavelengths were used in the investigation to show that local thermodynamic equilibrium exists at 1.0 and 0.5 atm and that within the experimental error the bound states $^2p_6$ and above are populated with a Boltzmann distribution at all the pressures investigated. (auth) (UK)

41554 MEASUREMENT OF ELECTRON COLLISION FREQUENCY BY OPEN PLASMA RESONATORS. Akao, Y.; Ida, Y. (Nagoya Univ., Japan). Elec. Eng. Jap. (Engl. Transl.), 87: 1-7(Aug. 1967).

It was shown that both the electron density and the collision frequency may be measured by the resonator technique. The open resonator technique of measurement, compared to the ordinary cavity technique, has the following features. In the cavity perturbation method, the density and the collision frequency are determined from the variation of the resonant frequency and the Q. In the open plasma resonator, measurements are based on the Q and the actual resonant frequency, not their variations. This provides, therefore, a much more direct method which simplifies both the method of measurement and the experimental setup. In the plasma resonator, measurements are made at much lower frequencies, compared to the cavity measurement, and, therefore, it is convenient for high-density plasmas. If the collision frequency is large so that the field in the resonator may not be approximated by the lossless field, the method of plasma diagnostics described here is invalid. (BBB)

41555 PRODUCTION OF A HIGH-TEMPERATURE DENSE PLASMA BY GAS BREAKDOWN WITH THE AID OF A LASER. Vanyukov, M. P.; Venchikov, V. A.; Isaenko, V. I.; Pashinin, P. P.; Prokhorov, A. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 7: 251-3(May 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 321-4(May 5, 1968).

The use of the breakdown produced by focusing large-power coherent optical radiation is one of the most promising methods of obtaining a hot plasma with the aid of lasers. The results of an experiment on the measurement of the temperature of the plasma of the "spark" in air and in the mixture of air in deuterium, in the pressure interval 70 to 160 mm Hg are presented. (TSS)

41556 A NEW METHOD FOR DETERMINATION OF PLASMA ELECTRON TEMPERATURE IN THE FLOATING DOUBLE PROBE. Dote, Toshihiko (Inst. of Physical and Chemical Research, Saitama, Japan). Jap. J. Appl. Phys., 7: 964-5(Aug. 1968).

Modifications of the floating double probe method developed by Johnson and Malter have been based upon some approximate analyses of the current–voltage characteristic and have yielded incorrect estimates of the electron temperature when the slope of the positive ion saturation current against the probe voltage is large. A new method is proposed for determination of electron temperature under a more rigorous analysis of the floating double probe characteristic. (TSS)

41557 SATURATION ELECTRON CURRENT OF A CYLINDRICAL PROBE IN A MAGNETIC FIELD. Amemiya, Hiroshi; Dote, Toshihiko (Inst. of Physical and Chemical Research, Saitama, Japan). Jap. J. Appl. Phys., 7: 956(Aug. 1968).

Previous experiments on a cylindrical probe in magnetized plasmas indicate that the saturation electron current density depends on $\omega\tau$ (ω is electron cyclotron angular frequency, τ is electron mean collision time) and the gas pressure. The Bohm formula is used in a quantitative treatment of these experimental results. (TSS)

41558 DENSITY MEASUREMENTS OF THE LASER-PRODUCED PLASMA BY LASER LIGHT SCATTERING. Izawa, Yasukazu; Yamanaka, Tatsuhiko; Tsuchimori, Noriyuki; Onishi, Masanori; Yamanaka, Chiyoe (Osaka Univ.). Jap. J. Appl. Phys., 7: 954(Aug. 1968).

The time-resolved densities of laser-produced plasma measured by the scattering of ruby laser light are described. (TSS)

41559 DETERMINATION OF SOME TRANSPORT PROPERTIES OF ARGON FROM TRANSIENT ARC BEHAVIOUR. Konjevic, N.; Hearne, K. R.; Edels, H. (Univ. of Liverpool). Z. Phys., 214: 109-26(1968).

A new method is described which enables the electrical conductivity and electron mobility to be derived from the measurement of either the decay, following interruption, or response of a wall stabilized arc to a step change in current. This was achieved by using a laser interferometer to record the corresponding change in electron density. The method was applied to arcs of different radii and the derived transport properties are given in the range 8,800 to 12,200°K for argon at atmospheric pressure. (auth)

41560 MEASUREMENT OF THE ION TEMPERATURE IN THE ISAR III THETA PINCH BY LASER FORWARD SCATTERING. Roehr, H.; Decker, G. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 214: 157-67(1968).

An experiment which allows measurement of a collective scattering spectrum of a plasma in the forward direction (7°) in a single discharge is described. The ion temperatures were determined from the scattering spectra for filling pressures between 10 and 100 μD_2. To improve accuracy the electron temperature was also measured by a 90° scattering experiment. In all cases measured spectra agreed within experimental accuracy with those expected of thermal plasmas. The electron temperatures were in all cases approximately 175 eV near the time of maximum B field. However, the ion temperature changed from about 650 eV at 10 μD_2 to about 175 eV at 100 μD_2. This behavior is expected from heating and loss mechanisms characteristic of theta pinches. The ion temperature obtained from neutron measurements (1300 eV at 10 μD_2) is higher, than that obtained from the laser scattering experiment. A locally varying ion temperature or superthermal fluctuations could explain the discrepancy. (auth)

41561 THEORY OF INDUCTION METHOD OF PLASMA VELOCITY MEASUREMENTS. Proshkin, V. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 147-9(Jan.-Mar. 1968). (In Russian).

Some questions of the theory of the induction method for the

measurement of plasma velocity are examined. It is indicated that under given reading conditions of the induction transducer, gradients of electron pressure, temperature, and space charge can be substantially affected at the plate of the induction transducer. In other cases the measured velocity will be less distinctive from the center of mass. (tr-auth)

41562 IMPROVED STARK PROFILE CALCULATIONS FOR THE HYDROGEN LINES Hα, Hβ, Hγ, AND Hδ. Kepple, P; Griem, Hans R. (Univ. of Maryland, College Park). Phys. Rev., 173: 317-25(Sept. 5, 1968).

The frequency distributions of the first four Balmer lines broadened by the local fields of both ions and electrons in a plasma are calculated in the classical path approximation. The electron collisions are treated by an impact theory accounting for upper- and lower-level perturbations and allowing (approximately) for level splittings caused by the ion fields, finite duration of the collisions, and screening of the electron fields. Ion effects are calculated in the quasistatic, linear Stark-effect approximation, using Hooper's distribution functions, which include correlation and shielding effects to high orders. Theoretical uncertainties (mainly from the impact approximation) generally increase with density, frequency separation from the line center, and decreasing temperature. However, they only exceed ~10% when a substantial fraction of the electrons begins to act quasistatically, and agreement with measured linewidths is within 10% in all cases. (auth)

41563 MEASURED SHIFTS OF CESIUM ATOMIC LINES: CORRELATION WITH ELECTRON DENSITY DERIVED FROM WIDTHS. Majkowski, R. F.; Donohue, R. J. (General Motors Corp., Warren, Mich.). Phys. Rev., 173: 177-83(Sept. 5, 1968).

The shifts of lines of the sharp, diffuse, and fundamental series of atomic cesium were measured for an rf electrodeless discharge in which the electron density was varied from 0.5 to 3×10^{14} cm^{-3} with a temperature range from 2600 to 3100°K. The shift values, which ranged from 0.008 to 1.4 Å, agree to ±20% with the theoretical Stark-broadening predictions for the 6P–10S, 6P–11S, 6P–12S sharp-series members: 6P–9D, 6P–10D, 6P–11D diffuse-series members; and the 6D–5F, 6D–6F, 6D–7F, 6D–8F fundamental-series members. The measured shifts exhibit a definite trend with quantum number n for all three series. At low values of n, measured shifts are greater than those computed from Stark-broadening theory, whereas measured shifts are less than theory for high n. Certain assumptions in the Stark-broadening theory are shown not applicable to most of those lines where disagreement between theory and experiment is greatest. (auth)

41564 ELECTRON BROADENING OF ISOLATED SPECTRAL LINES. Zaidi, Haider R. (Univ. of Tennessee, Knoxville). Phys. Rev., 173: 132-5(Sept. 5, 1968).

The electron broadening of an isolated atomic transition is calculated using the propagator approach. Electron correlations are included, and therefore the divergences arising in the impact-limit calculations are eliminated. The general expression for width reduces to previously obtained results if the correlations are neglected. The case of plasmon broadening is also considered. In this case, the width parameter has resonance-type frequency dependence, resulting in considerable deviation from Lorentz profile. Under suitable conditions "sidebands" appear about a "forbidden line." (auth)

41565 MEASUREMENT OF CONDUCTIVITY OF SEEDED FLAME PLASMAS. Koyama, K.; Sekiguchi, T. (Tokyo Univ.). Elec. Eng. Jap. (Engl. Transl.), 87: 12-19(June 1967).

Conductivity measurements for flame plasma seeded with potassium and powder oxides of low work function are presented, as well as a method that can be used to measure the conductivity of high-temperature flame plasmas (2500 to 3000°K). The measurement equipment consisted of an apparatus for measuring the conductivity by the impedance variation method, an apparatus for measuring the collision frequency of electrons and the electron density by microwave, an apparatus for measuring the temperature by NaD line inversion method and by the thermocouple, a seed injection apparatus, and a combustion apparatus. In the strongly oxidizing, high-temperature flame, neither probes nor electrodes could be used for the temperature measurement because of their low melting points and electrode voltage drops. Therefore, a microwave (75 GHz, wavelength 4 mm) method and a high-frequency wave (10 MHz) method in which the measurement could be performed without disturbing the flame plasmas were used. Potassium salts (alkaline metal seeds) and BaO, CaO, and SrO (powder seeds with low work function) were tested by the NaD line inversion method. It was found that potassium had the largest conductivity among the seed substances tested. (BBB)

41566 LIMITATIONS OF THE UTILIZATION OF THE SPECTROSCOPIC METHOD FOR THE DETERMINATION OF THE CONCENTRATION OF CHARGED PARTICLES IN LOW-TEMPERATURE PLASMAS AND ITS ERROR. Grechikhin, L. I. (Inst. of Physics, Minsk). Teplofiz. Vys. Temp., 6: 507-12(May-June 1968). (In Russian).

The basis for the limitations of the utilization of the spectroscopic method for the determination of the charged-particle concentration in low-temperature plasma is given. The errors in the method and methods for their elimination are analyzed. (tr-auth)

41567 THE DETERMINATION OF THE ABSORPTION COEFFICIENT OF PLASMA WITH USE OF THE GASEOUS OKG. Burakov, V. S.; Naumenkov, P. A.; Ivanov, V. P.; Khomenko, I. L. (Inst. of Physics, Minsk). Teplofiz. Vys. Temp., 6: 513-17(May-June 1968). (In Russian).

Methods were presented for the determination of the absorption coefficient of plasma by means of the gas laser. The associated electronic apparatus for registering, in time units, the flashes of nonattenuated and strongly attenuated plasma radiation of the lazer is described. Measurements were made on translucent plasma in capillaries, characterized by the optical density $kl \approx 5$. (tr-auth)

41568 INVESTIGATION OF THE ELECTRON DENSITIES IN DISINTEGRATING PLASMA OF A PULSE DISCHARGE. Tatarinov, V. V.; Poleshchuk, L. T.; Mel'chenko, V. S. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 131-3(1968). (In Russian).

Determination of electron densities at the high electron concentration region presents serious difficulties. A laser interferometer was used to overcome these problems; it involved amplitude modulation of the intensity. The minimum electron density, $n_{e\ min.}$ determined by a single surge in a plasma, may be calculated; the formula used also allows determination of the concentration distribution. The method was applied to the study of the electron-density drop of aperiodic ^3He and Ar plasmas. The results revealed that the volume recombination plays a more important role in these systems than the removal of charged particles by diffusion. An equation was derived to describe the initial stage of the decay of the plasma. (TTT)

Kinetics of Plasma

Refer also to abstract 40378.

41569 (NP–17527) TOROIDAL SCREW PINCH. Rijnhuizen Report 68-45. Bobeldijk, C. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). May 1968. 62p. Dep.

Thesis. Submitted to Utrecht Univ., Netherlands.

Experiments and theory are described on the screw pinch, a toroidal plasma column produced and confined by a helical magnetic field. The properties of the plasma, the distribution of the magnetic field, and the position of the column were determined. All signals are highly reproducible, even if the pitch of the magnetic field is varied between wide limits. Existing magnetohydrodynamic stability theories predict instability for a plasma column in vacuum in this configuration. As a result of this investigation, it appears that these theories are not applicable to the screw pinch, since it is not surrounded by vacuum, but by a pressureless plasma with low density and high conductivity. As a result of the way in which the screw pinch is formed, currents run in this outside region which cause the pitch of the magnetic field to be homogeneous and constant. This has important consequences for equilibrium and stability. A new formula was developed for the equilibrium position of the column. This position turns out to be considerably less eccentric than it would have been in the case where the field outside the column had a vacuum configuration. Of equal importance is the fact that, according to a normal-mode analysis, the screw pinch is completely stable (even for the m = 1 mode), as long as β does not surpass a critical value β_c. This critical β depends on the applied pitch and on the radius of the plasma column r_o. For a pitch of 0.6 m and a radius of 0.02 m, β_c is equal to 6%. The same column, surrounded by vacuum, would have been highly unstable. A calculation of the inductances of the screw pinch was made. (auth)

41570 (ORO–3458–13) THE THEORY OF PLASMA TURBULENCE AS APPLIED TO EXPERIMENTAL PHENOMENA. Drummond, W. E. (Texas Univ., Austin). Apr. 1968. Contract AT(40-1)-3458. 11p. Dep. CFSTI.

The two-stream instability for a cold electron beam passing through a cold plasma is discussed in the limit where the beam density is small compared to the plasma density. The dispersion relation is examined in terms of its topological behavior as the temperature of the beam particles is increased from zero to some finite value. It is shown that the three modes of the two-stream instability go continuously over into the one-mode bump instability. The effects of nonlinearity in systems where a zero temperature

beam is passed through a lower-temperature plasma is also considered. (TSS)

41571 (TID-24563) INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES. Quarterly Report No. 8, September 1-November 30, 1967. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Contract AT(40-1)-3405. 17p. Dep. CFSTI.

The installation of the Q machine was completed, and some preliminary experiments and calibration are described. With the machine in operation, the program was provisionally divided into three major parts: (1) physics of plasma waves and instabilities, (2) physics and technology of Q machines, and (3) general experimental methods. A brief description of these topics and some early results are given. (auth)

41572 DETERMINATION OF THE RADIAL INTENSITY DISTRIBUTION OF RADIATION IN CYLINDRICAL PLASMA. Bielski, A.; Kaczmarek, W.; Kubrycht, J.; Wolnikowski, J. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol., 33: 701-9(May

A survey is given of several numerical methods of calculation of radial intensity distribution i(r) of the radiation in an axially symmetric plasma on the basis of observed intensity distribution I(x). The influence of errors in the measurement of the intensity distribution I(x) on the maximal error of calculated radial intensity distribution i(r) is discussed. A method of i(r) calculation is presented, which is the least sensitive to the error of I(x) measurement and which provides sufficient accuracy in the solution of Abel's integral equation occurring in the problem. (auth)

41573 DAMPING AND REFLECTION OF ION-ACOUSTIC WAVES. Buscher, H. T.; Gorman, C. D. (McDonnell Co., St. Louis). Phys. Lett., 27A: 308-9(July 15, 1968).

Reflection of ion-acoustic wave pulses from sheaths in argon plasmas was observed for normal and 45° incidence angles. Two rates of exponential spatial damping were found for parallel-plane electrode geometry in both argon and xenon. (auth)

41574 HARMONICS IN ION WAVE PROPAGATION. Ohnuma, T.; Hatta, Y. (Tohoku Univ., Sendai). Phys. Lett., 27A: 316-17(July 15, 1968).

The second-harmonic signal in the propagation of ion wave with amplitude is found to grow spatially in some region. (auth)

41575 DETERMINATION OF THE DIFFUSION AND THERMODIFFUSION COEFFICIENTS OF A MULTICOMPONENT THERMAL NONEQUILIBRIUM PLASMA IN A STATIONARY ELECTROMAGNETIC FIELD. Claassen, H. A. (Kernforschungsanlage, Juelich, Ger.). Phys. Lett., 27A: 280-2(July 15, 1968).

The transport coefficients in the diffusion equations for the components of a magnetized thermal nonequilibrium plasma were derived, using a complex representation of the vector field components perpendicular to the magnetic field direction. (auth)

41576 ELECTRON ENERGY RELAXATION IN NITRIC OXIDE MAGNETOPLASMAS. Rao, K. V. Narasinga; Taylor, R. L. (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Lett., 27A: 296-7(July 15, 1968).

Electron energy relaxation time constants were measured in nitric oxide magnetoplasma. The fractional energy loss factor G_1 at thermal energies is determined to be 10^{-1}, an order of magnitude larger than in oxygen. (auth)

41577 DIRECTIONAL TWIN PROBE FOR THE MEASUREMENT OF PLASMA CURRENT. Ariga, Seiichi (Kyoto Univ.). Jap. J. Appl. Phys., 7: 955(Aug. 1968).

A method is proposed for measuring plasma current distribution using a directional twin probe which consists of a pair of Langmuir probes. This method may be applicable to the plasma in which usual Langmuir probe theory holds. (TSS)

41578 INVESTIGATION OF PLASMA EXPANSION IN A UNIFORM FIELD AND SHOCK FORMATION DUE TO A MAGNETIC BARRIER. Miyoshi, Yasunori; Okamoto, Yukio (Nagoya Inst. of Tech., Japan). Jap. J. Appl. Phys., 7: 927-35(Aug. 1968).

Behavior of plasma expanding along a uniform guide field and the thermalization processes of the kinetic energy of the plasma flow by shock wave due to a magnetic barrier are investigated with the parameter of initial plasma. Longitudinal expansion of a plasma in a uniform guide field is accompanied by a decrease in the density and the temperature. The decrease in the temperature is smaller than the density decrease. This seems to be in agreement with a model, which has been applied on Bille en Tête experiment. Shock wave propagates in the upstream direction accompanying the increasing of the temperature and the density behind the shock front. This phenomenon is clearer in the case of lower-density and higher-temperature plasma. (auth)

41579 ION CONVERSION IN AN ARGON AFTERGLOW. Cronin, J. C.; Sexton, M. C. (University Coll., Cork, Ireland). J. Phys. D, 1: 889-93(July 1968).

A 9 GHz free-space microwave interferometer was used to measure the electron density decline over the range 10^{11} to 10^{10} cm^{-3} in the afterglow of a pulsed argon discharge in a 12.7 cm diameter cylindrical tube (characteristic diffusion length $\Lambda = 2.46$ cm). In the range 0.14 to 0.61 torr the results are interpreted in terms of the ion conversion mechanism $Ar^+ + 2Ar \rightarrow Ar_2^+ + Ar$. The conversion frequency, found to be 376 p_0^2 s^{-1} (p_0 being the pressure reduced to 273°K), is compared with the available theoretical values. Owing to the high electron density and large-diameter discharge tube the method is more suitable for the measurement of this parameter in argon than were previous microwave studies. (auth) (UK)

41580 OSCILLATIONS PRESENT IN PLASMA-ELECTRON HEATING BY AN ELECTRON BEAM. Alexeff, I.; Guest, G. E.; Montgomery, D.; Neidigh, R. V.; Rose, D. J. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 21: 344-7(Aug. 5, 1968).

Oscillations of electrostatic fields present when electrons are strongly heated by electron-beam plasma interaction reveal large-amplitude oscillations with $\omega/k_{||} \lesssim v_b$, the electron-beam speed; $\omega \approx \omega_{ce}/10$, where ω_{ce} is the electron gyrofrequency; coherence lengths of roughly a few wavelengths (≪plasma length); and maximum electrostatic potential in the wave approaching the applied beam voltage. A gross compatibility is found between the observed frequencies and wavelengths and the predictions of a linear theory. (auth)

41581 VALIDITY OF THE UNCOUPLED THEORY OF LONGITUDINAL ELECTRON OSCILLATIONS IN A BOUNDLESS MAGNETOPLASMA. Babler, Gary M.; Willett, Joseph E. (Univ. of Missouri, Columbia). J. Appl. Phys., 39: 3527-34(July 1968).

An investigation is made of the uncoupled approximation for longitudinal electron oscillations in a boundless, nonrelativistic, Maxwellian, collisionless plasma in the limit of a strong external magnetic field. A simple formula is derived for the first-order correction to the complex frequencies due to coupling to transverse oscillations. Calculations for the lowest-frequency, least-damped oscillation indicate that at short wavelengths the coupling is significant only for relativistic electron thermal velocities. At long wavelengths for which the phase velocity is not negligible compared to the speed of light, the coupling is significant. (auth)

41582 HEAT TRANSFER TO THE SOLID WALL WITH A POTENTIAL DIFFERENCE BETWEEN IT AND THE PLASMA. Kamizawa, Jun (Tokyo Univ.). Nippon Kikai Gakkai Rombunshu, 33: 1847-52(Now. 1967). (In Japanese).

To examine the electrical effect in the heat transfer, a variety of potential differences were given between the plasma and solid wall, and the change in the heat flow was studied. A copper pipe of outer diameter 1 mm was inserted in the 1-atm argon plasma jet, and the potential difference was varied and the heat flow into the copper pipe was measured. Also, the current into the pipe was measured. The following are discussed: the work function of copper; occurrence of Joule's heat in the low-temperature region; increase of the heat flow by application of a positive voltage; minimization of the heat flow by a negative potential slightly from the float potential. (NSA of Japan)

41583 BEHAVIOR OF THE HIGH-TEMPERATURE PLASMA IN A THETA PINCH. Hayashi, Izumi; Seno, Yoshibumi (Tokyo Inst. of Technol.). Denki Gakkai Zasshi, 87-11: 2222-31(Nov. 1967). (In Japanese).

An experimental study was carried out on the theta-pinch plasma, with a gradual rise of the external magnetic field. The results obtained are as follows: (1) At the first and the second half-wave, the discharge is slight, and at and after the fourth half-wave the radial drift of plasma increases with the time. (2) With $t \lesssim 3$ μs, the effect of a magnetic probe upon the plasma is very small. With $t > 3$ μs, the accuracy of an electrostatic probe rapidly decreases due to the evaporation of probe material. (3) With $t = 0$, a magnetic field of about 0.17 Wb/m^2 is trapped near the tube axis, but with $t \simeq 2$ it disappears. (4) The contraction of a plasma cylinder starts about 5 mm inside of the discharge-tube wall. (6) A radial electric field E_r occurs due to the electron $E_0 \times B_z$ drift. (7) The electron temperature and density rapidly increase with $T \simeq 2$ μs of magnetic field disappearance. (NSA of Japan)

41584 FOCUSING PROPERTIES OF SEMI-CONFINED LINEAR PLASMA LAYER IN THE CASE OF AN INTERNAL SOURCE. Orlov, Yu. I. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 317-20 (1968). (In Russian).

Following up the author's earlier studies on the refraction and focusing of spherical waves in nonhomogeneous media, the prob-

lem was examined for the case of a semi-confined, linear plasma layer. On the basis of the fact that refraction of spherical waves in a nonconfined, nonhomogeneous medium is accompanied by an ideal focusing of the field, forming a nonspecific caustic curve, it can be shown that the plane interface boundary exerts an additional focusing action on the field, resulting in the appearance of specific points in the free space on the caustic surface. On the basis of this study, it was possible to generalize V. M. Babich's theory on the interaction of the light to include specific caustic curves with regression nodes and points or specific caustic foci; the characteristics of the light field are conserved at the corresponding points of the same type of sources. (TTT)

41585 DIGITAL COMPUTER PROGRAM FOR COMPUTING ION-SATURATION CURRENTS FROM A PLASMA OF UNIFORM DENSITY IN A TWO-DIMENSIONAL GEOMETRY. Harrison, John L. (Princeton Univ., N. J.). J. Appl. Phys., 39: 3827-36 (July 1968).

The shape of the surface from which ions are extracted is a major factor in determining the tractability of an ion beam for fine focusing. In duoplasmatron-type ion sources the extraction is made from a plasma, and the shape of the plasma surface has been difficult to define. The paper describes a computer program, which both determines the shape of a plasma surface in a known extraction geometry with known current density at the surface and calculates trajectories of particules leaving this surface. (auth)

41586 DISCUSSION OF "TWO-STREAM INSTABILITY IN PLASMA". Halpern, Gerald (Goddard Space Flight Center, Greenbelt, Md.). J. Appl. Phys., 39: 4042-3(July 1968).

Disagreements with a paper by Uberoi and Bhatnagar [J. Appl. Phys., 38: 3801(1967)] (UB) on the two-stream instability in an inhomogeneous two-fluid plasma are pointed out. It is concluded that the transverse oscillations in a uniform two-stream plasma slab are always stable. The instabilities described in the UB paper are not driven by the streaming of the plasma, but are growing transverse oscillations stimulated by radiation sources external to the plasma. The sheath fluctuation mechanism for instability cannot be applicable, since the apparent instability persists in the limit $\beta \to 0$ in which the sheath vanishes. (A.G.W.)

41587 QUANTUM CORRECTIONS TO THE PAIR DISTRIBUTION FUNCTION OF A CLASSICAL PLASMA. Diesendorf, Mark; Ninham, Barry W. (Univ. of New South Wales, Kensington). J. Math. Phys. (N. Y.), 9: 745-52(May 1968).

Quantum-mechanical corrections to the pair distribution function of a plasma at high temperature and low density were calculated to order e^2 in the interaction, using standard diagram perturbation techniques. Both the effects due to quantum statistics (exchange) and the finite size of a wave packet (dynamic screening), were considered. (auth)

41588 OSCILLATIONS AT THE ANODE OF ALKALI-VAPOR ARC PLASMAS. Robertson, Harry S. (Univ. of Miami, Coral Gables). J. Appl. Phys., 39: 3849-56(July 1968).

The theory of the anode sheath for quasineutral collision-dominated arc plasmas is developed, both for the steady state and for behavior following emission of a burst of ions from the anode surface. It is shown that the decay time constant for such a burst is related to the ambipolar diffusion time, $\tau = \Lambda^2/D_a$, where Λ is the appropriate diffusion length. The ion burst, a consequence of field emission from the anode surface, causes a local sharp decrease in the electric field strength, followed by a gradual increase as the ion cloud dissipates. A new burst of field-emitted ions begins another cycle. A summary is given of experimental work on anode-spot oscillations, some of which supports the predictions of the theory. (auth)

41589 NONLINEAR GENERATION OF TRANSVERSE FLUCTUATIONS FROM LONGITUDINAL FLUCTUATIONS IN AN INFINITE STABLE PLASMA. Bornatici, M.; Engelmann, F. (EURATOM–CNEN, Frascati, Italy). Nuovo Cim., 56B: 220-38(Aug. 11, 1968).

The stationary spectrum of transverse electric field fluctuations, generated by nonlinear interaction of longitudinal waves, in a homogeneous and isotropic electron plasma of infinite extension and in the absence of external fields, is calculated. Only the lowest-order nonlinear effect, yielding transverse waves with frequencies somewhat above $2\omega_p$ and, respectively, small compared to ω_p, is considered, including, however, nonresonant modes. An estimate of the order of magnitude of the effect is given for equilibrium fluctuations, which may serve as a starting point for evaluating its importance in cases where enhanced longitudinal fluctuations are present. (auth)

41590 PHASE-SPACE SYMMETRIES OF A RELATIVISTIC PLASMA. Santilli, R. M. (Univ. of Miami, Coral Gables, Fla.). Nuovo Cim., 56B: 323-6(Aug. 11, 1968).

It is shown that any relativistic plasma possesses well-defined local symmetries in phase-space. On the contrary, in configuration or momentum space there are some difficulties for the symmetry approach, since a relativistic plasma in interaction with an external electromagnetic field is not invariant under the inhomogeneous Lorentz group (in agreement with the no-interaction theorem) and, generally, the same invariance under the rotation group O_3 is broken. (M.O.W.)

41591 ION WAVE REFLECTIONS AS OBSERVED IN A PERTURBED PLASMA. Aksornkitti, S. (Univ. of Iowa, Iowa City); Hsuan, H. C. S.; Lonngren, K. E.; Alexeff, I. Phys. Fluids, 11: 1838-40(Aug. 1968).

The experimental observation of the reflection of ion acoustic waves from a negatively biased grid immersed in a plasma is reported. Reflection is detected only in the region where the plasma is "perturbed." (auth)

41592 QUASILINEAR THEORY OF RESONANT DIFFUSION IN A MAGNETO-ACTIVE, RELATIVISTIC PLASMA. Lerche, I. (Univ. of Chicago). Phys. Fluids, 11: 1720-7(Aug. 1968).

Equations are set up to describe the quasilinear behavior of a collisionless, relativistic plasma immersed in a uniform, homogeneous magnetic field. Use of the adiabatic assumption, together with an approximation to resonant denominators, enables an estimate to be given of the change of the distribution function due to the turbulent waves. In the particular cases of pure electrostatic waves, magneto-sonic waves, and cyclotron waves, estimates are made of the rate of energy change of resonant particles. It is shown that some modes exhibit resonant diffusion only when relativistic particles are present and for which there is no non-relativistic counterpart. It is believed that this calculation may be of some interest in situations where relativistic particles play, or are suspected of playing, a major role; for example, the galactic cosmic ray gas and nonthermal radio sources. (auth)

41593 SECOND-ORDER CONTRIBUTIONS TO TRANSPORT PROCESSES IN A PLASMA. Luks, K. D. (Univ. of Notre Dame, Ind.); Davis, H. Ted. Phys. Fluids, 11: 1728-33(Aug. 1968).

The second-order pressure tensor and heat-flux vector are obtained for a one-component plasma by applying the Chapman–Enskog method of solution to the Balescu–Guernsey–Lenard kinetic equation. To illustrate the temperatures and densities at which second-order effects may be important in plasmas, the hydrodynamic problem of Couette flow between flat plates is analyzed. (auth)

41594 UNIFIED QUASILINEAR THEORY OF WEAKLY TURBULENT PLASMAS. Wu, C.-S. (California Inst. of Tech., Pasadena. Univ. of Maryland, College Park). Phys. Fluids, 11: 1733-44(Aug. 1968).

A quasilinear theory is formulated which includes the microscopic fluctuation fields as well as the coherent waves. The study emphasizes those cases in which the propagating mode of the fluctuation field gives rise to a dominant contribution to the particle correlation. In other words, in these cases the spontaneous Cherenkov emission of plasmons can play a more important role than the two-particle collision process. The instability which is responsible for the turbulence can be of either an electrostatic, electromagnetic, or mixed nature. The effect of an external magnetic field is also considered in the present theory. The final result is valid for an arbitrary ratio of the energy density of the coherent wave to that of the fluctuation field although the condition of weak turbulence is imposed throughout the analysis. (auth)

41595 STATISTICAL PARTICLE ACCELERATION IN RANDOM FIELDS. Puri, S. (Stanford Univ., Calif.). Phys. Fluids, 11: 1745-53(Aug. 1968).

Motion of charged particles in arbitrary random electric and magnetic fields is analyzed, and the statistical acceleration rate is derived in terms of power spectra of functions of the applied fields. The treatment is extended to stochastic acceleration in a magnetic mirror; upper and lower bounds (differing by a factor of 2) for the particle acceleration rate are derived for the case when the half-power spectrum of the electric field spans the spectrum of particle gyrofrequencies in the mirror. (auth)

41596 TRANSITION OF THE DISPERSION ROOTS FROM BEAM-TYPE TO LANDAU-TYPE SOLUTIONS. O'Neal, T. M.; Malmberg, J. H. (Gulf General Atomic, Inc., San Diego, Calif.). Phys. Fluids, 11: 1754-60(Aug. 1968).

The roots of the dispersion relation describing the linear interaction between a plasma and a relatively low-density electron beam are investigated. The dispersion curves exhibit a nontrivial

change in topology at a particular value of the appropriately scaled thermal velocity of the beam. (auth)

41597 NONLINEAR EFFECTS OF LARGE-AMPLITUDE PLASMA WAVES. Wharton, C. B.; Malmberg, J. H.; O'Neil, T. M. (Gulf General Atomic, Inc., San Diego, Calif.). Phys. Fluids, 11: 1761-3(Aug. 1968).

The oscillations of resonant electrons in the potential of a large-amplitude, spatially propagating plasma wave result in: (1) periodic maxima in space of wave amplitude, (2) growth of sidebands on the transmitted frequency, and (3) periodic enhancement of the energy of the trapped electrons. Measurement of these effects is reported. (auth)

41598 CORRELATION MEASUREMENTS OF ION ACOUSTIC WAVES IN A HIGHLY IONIZED PLASMA. Gunshor, R. L.; Noon, J. H.; Holt, E. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Fluids, 11: 1763-7(Aug. 1968).

Correlation techniques are applied to low-frequency probe signals detected in a highly ionized hollow-cathode gas-fed arc plasma in an axial magnetic field. One set of oscillations is found to be an ion acoustic wave propagating at an angle to the magnetic field. Drift waves are also observed. (auth)

41599 INSTABILITIES IN PARAMETRIC OSCILLATIONS OF A PLASMA. Prasad, R. (Bengal Engineering Coll., Howrah, India). Phys. Fluids, 11: 1768-74(Aug. 1968).

Dispersion relations for longitudinal and transverse waves propagated perpendicularly to an externally applied high-frequency electric field in a fully ionized plasma have been obtained. It has been shown that in addition to $\omega \approx \omega_0$ (ω_0 is the characteristic electron frequency), the longitudinal mode may be excited with frequencies $\omega \simeq \Omega_k \pm \nu$ ($\Omega_k^2 = c^2k^2 + \omega_0^2$, ν is the external field frequency); and under certain conditions the excitation near ω_0 may be unstable. For the transverse mode instabilities may occur owing to resonance between a backward and a forward moving wave of the same frequency and vice versa. Apparently these are owing to the periodic nature of the dispersion relations found and to the mode–mode coupling present. (auth)

41600 NONLINEAR INTERACTION OF ELECTROMAGNETIC WAVES IN A COLD MAGNETIZED PLASMA. Etievant, C. (Princeton Univ., N. J.); Ossakow, S.; Ozizmir, E.; Su, C. H.; Fidone, I. Contract AT(30-1)-1238. Phys. Fluids, 11: 1778-88 (Aug. 1968). (MATT-566).

The nonlinear interaction of electromagnetic waves propagating in a cold plasma across a magnetic field is investigated. The amplitude of the generated wave is evaluated, and numerical computations are given for two cases of interest: (a) the interaction of an extraordinary wave with an ordinary wave leading to the generation of an ordinary wave; (b) the interaction of two ordinary waves leading to the generation of an extraordinary wave. The results show that under appropriate conditions the detection of generated wave is feasible and the scheme should provide a diagnostic method for measuring the local density and its fluctuations in magnetized plasmas. (auth)

41601 PLASMA CURRENT DENSITY AND EQUILIBRIUM OF MAGNETICALLY TRAPPED PARTICLES. Siambis, John G. (Carnegie-Mellon Univ., Pittsburgh). Phys. Fluids, 11: 1793-6 (Aug. 1968).

The current density of a low-density collisionless plasma, confined in static equilibrium by a strong externally applied static magnetic field, is obtained in the limit of adiabatic motion for the charged particles. When there is no net streaming, to zero order in ϵ: the mass-to-charge ratio, along the field lines of the magnetic field, then the current density is of first order in ϵ, and its component along the field line is produced by three contributions. The first is due to the shear drift of the guiding centers along the field line. The second is due to the zero-order drift of the guiding centers along the field line, and the velocity space asymmetry in the first-order correction to the lowest-order distribution function. This asymmetry is due to the shear in the field lines. The third contribution is due to the component of the curl of the magnetization along the field line and is also related to the shear. A local macroscopic equilibrium relation for the gradient of the pressure is obtained from the divergence of the current density. (auth)

41602 COHERENT FORWARD SCATTERING OF MICROWAVES FROM DENSITY FLUCTUATIONS IN ALKALI PLASMAS. Iannuzzi, M.; Magistrelli, F.; Piperno, F. (EURATOM–CNEN, Rome). Phys. Fluids, 11: 1822-9(Aug. 1968).

An experimental study has been carried out on coherent forward scattering of microwaves from ion acoustic waves in alkali plasmas in a nonlinear regime. The experimental apparatus allowed quantitative measurements to be made with good accuracy. Geometrical and diffraction effects have been avoided by using a plasma filled wave guide. The dependence of scattering cross section on the amplitude of ion acoustic waves and on the frequency of the incident radiation has been studied in detail. The experimental results are in good agreement with the theoretical results. (auth)

41603 COLLISION-DOMINATED POSITIVE COLUMN OF A WEAKLY IONIZED GAS. Blank, J. L. (Yale Univ., New Haven, Connecticut and Bellcomm, Inc., Washington, D. C.). Phys. Fluids, 11: 1686-98(Aug. 1968).

To obtain criteria for the validity of the constant coefficient electron diffusion equation, the problem of the positive column is treated using the Boltzmann equation for the electrons. The problem is solved completely for the case of a constant electron-neutral recoil collision time for momentum transfer, in the limit where inelastic collisions play a weak role in determining the shape of the body of the electron distribution function. Here the bulk of electrons is confined by a space charge potential well, and except for a thin boundary layer near the wall, the electron density assumes a Boltzmann distribution, and the electron temperature and diffusion coefficient are constant. For a general collision frequency it is established that, unless the electron energy relaxation length is small compared with the macroscopic length scale, these results are correct only if the following conditions exist: the recoil collision time is reasonably constant over the domain which makes the major contribution to the velocity space moments of the electron distribution function, and the electron fluxes in configuration and velocity spaces are appropriately small. (auth)

41604 SCHEME OF REACTIVE ENERGY GENERATION DUE TO INTERACTION OF PLASMA AND THE TRAVELLING MAGNETIC FIELD. Kapustyanenko, G. G. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 3-8(Jan.-Mar. 1968). (In Russian).

It was shown that with calculation of the compressibility the equivalent impedance of plasma in a traveling magnetic field becomes complex. The relative component of the equivalent impedance of the plasma has an inductive character, if the velocity of the plasma with respect to the waves of the magnetic field is less than the speed of sound, and a capacitive character, if the slip rate is greater than the speed of sound. In the latter case, reactive energy, necessary for maintenance of the waves of the magnetic field in the channel, can be generated. (tr-auth)

41605 OHM'S LAW FOR PARTLY IONIZED PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS AT GREAT DIFFUSION VELOCITIES. Vaulin, E. P.; Starinskaya, N. B. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 1, 9-14(Jan.-Mar. 1968). (In Russian).

In the hydrodynamic approximation, a generalized Ohm's law is formulated for partially ionized plasma in crossed electric and magnetic fields. The phenomenon of slip or comparatively neutral ions and the nonlinear dependence of the strength of the friction between plasma components on the diffusion rate are considered. It is shown that with diffusion rates commensurate with the heat diffusion, the conductivity of the plasma substantially depends on the absolute current density under conditions of practical interest. (tr-auth)

41606 ORIGIN OF MOVING STRIATIONS IN PLASMA. Kawamura, M.; Matsumura, M. (Tokyo Inst. of Tech.). Elec. Eng. Jap. (Engl. Transl.), 87: 76-82(Sept. 1967).

Origin of the striae in positive plasma columns, that is the striated shape of light output with the wavelength of the order of the tube dia of the frequency near that of the ionization frequency, was studied. A study was made of the effect of: a change in the discharge current, abrupt change in dia, and magnitude of the transverse magnetic field (localized) on various parameters of the striation, particularly the frequency and the cutoff current. The experimental results showed that the frequency of the striation in a uniform dia discharge tube is determined at the front end of the tube. In a discharge tube with varying diameters, it was shown that a change in the frequency is largest if the localized magnetic field is placed at the point of the abrupt change in the site of the tube. This effect shows that a strong source of disturbances is present in those parts of the tube. It was concluded that the origin of the moving striation in a tube of uniform cross section is in the vicinity of the cathode, more exactly at the edge of the positive column. (BBB)

41607 AN EQUIVALENT CIRCUIT OF A CYLINDRICAL PLASMA COLUMN IN A WAVEGUIDE. Zakrzewski, Z. (Inst. of Fluid Flow Machines, Gdansk, Poland). Pr. Inst. Masz. Przeply., 36: 53-67(1967). (In Polish).

The introduction of plasma into a waveguide changes the field distribution in the waveguide. The effect of plasma on the propagation of the wave of fundamental mode can be described by means of conventional equations of a four-pole. In this paper an equivalent

circuit is presented, of a thin cylindrical column of homogeneous plasma in a rectangular waveguide with field distribution TE_{10}. Values of the elements of T system and of the scattering coefficients of the equivalent four-pole are given as functions of electron density and electron collision frequency. Numerical computations were performed with the use of the Elliott 803 computer. Finally, the approximate expressions for plasma having small and very large values of relative electron density are given. (auth) (NSA of Poland)

41608 MICROWAVE RADIATION FROM MAGNETOPLASMA. Terayama, K.; Takamoto, T. (Kansai Univ., Japan). Elec. Eng. Jap. (Engl. Transl.), 87: 34-41(May 1967).

The microwave radiation from the vicinity of the cathode in Ar^+ and Ne^+ plasmas was studied, particularly the relation between this radiation and the external magnetic field. Also measured were the $V_d - I_d$ characteristics (V_d is the discharge voltage and I_d the discharge current) of the discharge tube and the electron energy distribution in the vicinity of the cathode. Anomalous radiation from several to several hundred times larger than the usual level occurs in the vicinity of the cathode at cyclotron resonant frequency, its harmonic frequencies, and the frequency corresponding to the peak of heat radiation at $\gamma > 1$. When the anomalous radiation takes place, the $V_d - I_d$ characteristics become abnormal. That is, the discharge voltage reaches the maximum value V_{dm}, and then decreases to the stationary value. Furthermore, the electron energy distribution deviates from a normal state, and the electron beam groups are observed. From the experimental results of the discharge characteristics and the electron energy distribution, it was confirmed that when the anomalous radiation takes place, the plasma state deviates from a normal state. However, it was not possible to clarify the effect of the anomalous radiation on the instability caused by the interaction between plasma and the electron beam and also on the negative resistance of the discharge characteristics. Because of the complexity of plasma around the cathode drop, the anomalous radiation may be caused by other phenomena. When the discharge tube contains gases with large Ramsauer effect, anomalous radiation may take place due to the negative absorption phenomenon. However, since the anomalous radiation is observed in Ne where the Ramsauer effect is small, the nature of this anomalous radiation is different from that caused by the negative absorption. (BBB)

41609 NONEQUILIBRIUM LOW-TEMPERATURE PLASMA. Biberman, L. M.; Vorob'ev, V. S.; Yakubov, I. T. (Inst. of High Temperature, Moscow). Teplofiz. Vys. Temp., 6: 368-80(May-June 1968). (In Russian).

The assumptions developed previously on the diffusion character of the energy fluctuation of electrons, participating in inelastic collisions, are used for the simplification of the terms in the kinetic equation for free electrons. Equations for determining the distribution of the particles in discrete and continuous spectra are given. The question of the effect of the transition between excited states of atoms on the electron distribution is examined. (tr-auth)

41610 MECHANISM OF THE RADIATION PROCESS OF NITROGEN IN THE NONEQUILIBRIUM RANGE BEHIND THE SHOCK WAVE FRONT. Smekhov, G. D.; Losev, S. A. (Moscow State Univ.). Teplofiz. Vys. Temp., 6: 381-9(May-June 1968). (In Russian).

The results of the experimental investigation of the distribution of the radiation intensity of the first positive nitrogen system $N_2(1+)$ and the first negative nitrogen ion system $N_2^+(1-)$, propagating in the mixture 0.1 N_2 + 0.9 Ar, were reported. The processes, leading to the population of the electron states $B^3\Pi_g(N_2)$ and $B^2\Sigma_u^+$ (N_2^+), were examined. A mechanism for the kinetics of the process was proposed that explains the experimental results. The possibility of the excitation of the state $B^3\Pi_g(N_2)$ with electrons was shown. An evaluation was made of the velocity constants of the associative ionization of nitrogen in the temperature range from 8000 to 10,500°K. (tr-auth)

41611 IONIZATION RELAXATION BEHIND SHOCK WAVES IN AIR. Zheleznyak, M. B.; Mnatsakanyan, A. Kh. (Inst. of High Temperature, Moscow). Teplofiz. Vys. Temp., 6: 390-4(May-June 1968). (In Russian).

The processes of relaxation behind plane shock waves in air were examined for velocities of 9 to 12 km/sec. The profile of the nonequilibrium parameters were calculated, which showed numerically that the temperature of electrons differed from that of heavy particles. The calculated values of the intensity of the infrared radiation and of the ionization lengths agreed with the experimental data. (tr-auth)

41612 PROCESSES OF IONIZATION AND RECOMBINATION IN RAREFIED ACETYLENE–AIR FLAMES WITH SUPPLEMENTS OF LEAD AND BISMUTH. Taran, E. N.; Tverdokhlebov, V. I. (Dnepropetrovsk State Inst., USSR). Teplofiz. Vys. Temp., 6: 395-9(May-June 1968). (In Russian).

The concentrations of positive ions and the electron temperature according to the height of the rarefied acetylene–air flame with supplements of lead and bismuth were measured by the two-probe method. From curves of the dependence of the concentration of the positive ions on the distance from burner mouth, the apparent recombination coefficients were determined. It was established that in the zone of burnt gases of the flame with additions of lead and bismuth, electron–ion recombination occurs with ternary collisions. An evaluation was made of the quantity of molecular and atomic ions. (tr-auth)

41613 ENERGY BALANCE IN CAPILLARY DISCHARGE WITH EVAPORATING WALLS. Ogurtsova, N. N.; Podmoshenskii, I. V.; Shelemina, V. M. Teplofiz. Vys. Temp., 6: 400-5(May-June 1968). (In Russian).

An examination was made of the energy balance in capillary discharge with evaporating walls. The examination included the experimental determination of the electric resistance of the high-pressure plasma, the gasodynamic calculation of the mass transfer of the plasma, and the analysis of the radial thermal transfer in the channel. It was shown that for the majority of capillary discharge regimes, the loss to radiation plays a basic role in the energy balance. The dependencies of the temperature and pressure of the capillary discharge on the geometry of the capillary and the discharge current were explained by the position of the radiant heat exchange. (tr-auth)

41614 TEMPERATURE PROFILE OF ARCS OF SMALL CROSS SECTION. Kiselevskii, L. I.; Shimanovich, V. D.; Shipai, A. K. (Inst. of Physics, Minsk). Teplofiz. Vys. Temp., 6: 406-9 (May-June 1968). (In Russian).

The correlation between the temperature profiles and small-cross section arcs ($d \approx 1$ mm), obtained by spectroscopic measurements and by solution of the energy balance equation, is examined. The temperature values obtained by different means agree with each other and with the calculation temperature profiles. These can be used for the verification of the realization of conditions of local thermodynamic equilibrium in the source. (tr-auth)

41615 INVALIDITY OF THE CLASSICAL DESCRIPTION OF DEGENERATE DENSE PLASMAS. Norman, G. E.; Starostin, A. N. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 6: 410-15(May-June 1968). (In Russian).

The conditions for thermodynamic stability of plasmas are obtained. The Klein theorem is expanded by quantum statistics. The possible form of the dependence of the atomic concentration on the ion concentration in the dense plasma is considered. It is shown that for the calculation of the thermodynamics of dense plasma it is necessary to consider quantum effects. (tr-auth)

41616 EXPANSION AND THERMALIZATION OF PLASMA IN A NON-UNIFORM MAGNETIC CHANNEL. Hamada, Shigeo; Kawakami, Ichiro; Sato, Masatomo (Nihon Univ., Tokyo). J. Phys. Soc. Jap., 25: 542-62(Aug. 1968).

Theoretical investigations of the unsteady motion of plasma in a magnetic channel are made on the basis of the hydromagnetic theory of an ideal fluid. A set of o e dimensional equations on which the investigations are made is derived in the near-axis approximation from three dimensional equations. Using these equations dynamical expansion of an initially uniform plasma at rest contained in a region of strong magnetic field into a region of weaker field, and shock thermalization of the expanding plasma on colliding with a rigid wall (or with another flow in the opposite direction) or being decelerated by a magnetic barrier are investigated. Analyses are made both analytically and numerically. (auth)

41617 NONLINEAR KINETICS OF PLASMA. II. FUNDAMENTAL EQUATIONS RELATING TO ION PLASMA WAVE. Kurasawa, Takasi; Matsuura, Kenya (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap., 25: 562-86(Aug. 1968).

The kinetic equations relating to ion plasma wave (ion wave) in a weakly turbulent plasma are discussed from the viewpoint of the Hamiltonian formalism. The interaction Hamiltonians which describe various elementary processes occurring among electron, ion, electron plasma waves and ion waves are derived by extending the Bohm–Pines collective description of the electron plasma to a plasma in which both ions and electrons behave collectively. The wave-wave interactions of ion waves by the participation of ion and electron are discussed in detail. The equations describing the linear interactions between ion wave and electron (or ion) and three-wave interaction among electron plasma waves and ion wave are consistent with corresponding equations derived from the usual kinetic theory of a plasma. (auth)

41618 MILLIMETER-WAVE GENERATION WITH PLASMA DEVICES: THE STATE OF THE ART. McIntosh, Robert E. (Electronics Research Center, Cambridge, Mass.). Proc. IEEE (Inst. Elec. Electron. Eng.), 56: 1210-12(July 1968).

The electron beam–plasma interaction and the plasma multiplier have been investigated during the last decade in the hope that one or the other might have some application at millimeter wavelengths. So far the expectations for these devices have not been realized because of many unresolved engineering problems. Major difficulties are described here, and an attempt is made to evaluate the potential of both devices. (auth)

41619 PARAMETRIC EXCITATION OF ION WAVES. Yoseli, Morihiro (Electrotech. Lab., Tokyo). Denki Shikenjo Kenkyu Hokoku, No. 676, 1-41(Dec. 1967).

The parametric excitation of ion waves, which contain the ion plasma oscillation and the ion sound wave, are investigated both theoretically and experimentally. The ion plasma oscillation is excited in the mercury vapor plasma by the pumping oscillations at $2f_{pi}$ and at the frequency of a little lower than $\frac{2}{3}f_{pi}$, where f_{pi} is the ion plasma frequency. The threshold energy necessary for the parametric excitation of the ion plasma oscillation is larger at the frequency of $\frac{2}{3}f_{pi}$ than at $2f_{pi}$. It is observed that nonlinear effects, such as the intensity decrease, the frequency shift, and the frequency broadening, happen when the pumping field is large. It is found also that the ion sound wave is excited in mercury vapor plasma by the pumping oscillation at twice the frequency of the ion sound wave. The parametric excitation of ion waves is studied theoretically in the two cases: (1) in homogeneous plasmas when the incident pumping electric field modulates the electron drift velocity, plasma density, and electron temperature, and (2) in inhomogeneous plasmas when the external electric field is applied on the density gradient. The linearized hydrodynamic equations are solved in one-dimensional case and are reduced to a type of Mathieu equation. In the case of the parametric excitation of the ion plasma oscillation, the effect of the modulation of the plasma density on the parametric resonance is large compared with the effects due to the modulation of the electron drift velocity and the electron temperature, and the effect of the parametric excitation in the gradient of the plasma density. In the case of the parametric excitation of the ion sound wave, all of the parameters described above have comparatively large influence on it. This theory explains qualitatively the experiments of the parametric excitation of the ion plasma oscillation in a weakly ionized plasma except for the nonlinear behaviors. (NSA of Japan)

Production of Plasma

41620 (AD-662350) APPROACH TO RADIATION SOURCE DESIGN FOR MILITARY APPLICATIONS UTILIZING THE WALL-STABILIZED ARC AS AN EXAMPLE. Schreiber, Paul W.; Benedetto, Kenneth R. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Aug. 1967. 43p. (ARL-67-0179). CFSTI.

An approach to the selection of radiation sources for military applications is presented. A logical breakdown of the various types of discharge sources and a list of parameters to be considered are given. As an example, an analytical and experimental study of the fully developed laminar flow, argon electric arc discharge is included. A description of the arc facility and the diagnostic techniques used are presented. The analytical results are compared with experimental results. (auth) (USGRDR)

41621 (DESY-68/27) OPTICALLY STIMULATED PLASMA EFFECT ON ALUMINUM IN ULTRAHIGH VACUUM. Feuerbacher, Berndt (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1968. 44p. (In German). Dep.

The optically excited plasma resonance in Al was studied under uhv conditions in reflection and photoemission, using synchrotron radiation as the light source. Measurements were made between 500 and 1100 Å at various angles of incidence in both s and p polarization on freshly evaporated Al films at pressures of about 10^{-9} torr. A pronounced maximum in reflectivity and photoelectric yield in p polarization was found near the plasma frequency, which is the result of the plasma resonance. In the reflection spectrum a Brewster minimum is also found. Both structures are missing in s polarization. The influence of surface layers was studied by stepwise venting the system with air and oxygen. The reflectometer developed for the measurements is described. (auth)

41622 (IAE-1399) HOT PLASMA PRODUCTION DURING INJECTION OF CLUSTERS OF FAST ATOMS INTO MAGNETIC TRAPS. Kartashev, K. B.; Pistunovich, V. I.; Filimonova, E. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1967. 19p. (In Russian). Dep.

Descriptions are given of a new method for producing hot plasma in magnetic traps by injection of dense fast atom clusters. The capture of atoms is achieved either by the incoming cluster or by short-life plasma targets. (tr-auth)

41623 (NYO-3578-9) PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. Semiannual Report, February 1–July 31, 1968. Haught, Alan F.; Polk, Donald H.; Fader, Walter J. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Contract AT(30-1)-3578. 41p. (UARL-G-920365-9). Dep. CFSTI.

Production of high-temperature, high-density, spherically expanding free plasmas and the interaction of these plasmas with magnetic containment fields of mirror, cusp, and minimum-B geometry are being investigated experimentally and theoretically. The plasmas are produced by focused laser beam irradiation of a single micron-sized solid particle of lithium hydride which is electrically suspended in vacuum at the focus of a lens. Using this technique, free-expansion plasmas have been produced which measurements show to be essentially spherically symmetric, with a total ion charge corresponding to at least single ionization of all the $\sim 10^{15}$ atoms present in the initial solid particle, and with an average plasma energy in excess of 200 eV. Theoretical studies, using both detailed hydrodynamic calculations and a simplified integrated similarity model of the free plasma formation and development have been carried out. The plasma energies calculated with both models are in good agreement with the experimental measurements. The integrated similarity model has been used for calculation of the plasma energy over a wide range of the experimental parameters (particle size, focal spot size, laser power, and laser pulse duration) to determine the optimum conditions for maximum plasma energy and the limitations on the number of atoms which can be heated to this energy. Theoretical studies of the early plasma–magnetic field interaction, using the hydrodynamic model, have shown that the initial plasma formation and development is unaffected by the presence of magnetic fields of $\leq$10 kG field intensity. As a result, the plasmas generated in the plasma–magnetic field interaction are identical with those studied in the free-expansion experiments providing a well-defined set of initial conditions. Experimental studies of the interaction of these initially spherical, expanding plasmas with magnetic confinement fields of mirror and minimum-B geometry at field strengths up to 8 kG show that the plasma is contained at densities $>10^{13}/cm^3$ for as long as 10 μsec (minimum-B), and that the major plasma loss is through the mirror loss cones. Recent measurements have shown that less than 1% of the plasma escapes from the containment region in directions transverse to the magnetic field. From measurements of the ion energy of the plasma escaping at late times, the trapped plasma in these experiments is the thermalized laser-produced plasma. (auth)

41624 BOUNDARY CONDITIONS FOR A MAGNETIZED PLASMA AT A PLANE ELECTRODE. Claassen, H. A. (Kernforschungsanlage, Juelich, Ger.). Phys. Lett., 27A: 279-80 (July 15, 1968).

The collisionless theory of a plasma sheath at a plane electrode is modified to account for a stationary parallel magnetic field. The cyclotron frequencies $\omega_\alpha = e_\alpha B/m_\alpha$ are assumed to limit the electric field variation inside the sheath by the condition $(e_\alpha/m_\alpha)dE_y/dy \leq \omega_\alpha$. (auth)

41625 IMPROVEMENTS IN OR RELATING TO A CHARGED-PARTICLE SOURCE HAVING A LOW RATE OF FLOW OF NEUTRAL GAS. Etievant, Claude; Hubert, Pierre; Perulli, Mariano (to Commissariat a l'Energie Atomique). British Patent 1,114,634. May 22, 1968. Priority date Aug. 20, 1965, France.

The charged-particle source described includes a vacuum chamber having an axis of revolution or plane of symmetry and provided with a neutral gas inlet. The vacuum chamber contains an electron-emitter cathode and an extraction aperture disposed on the same axis or in the same plane. The source comprises, firstly, a plurality of electrodes disposed inside its vacuum chamber between the cathode and the extraction aperture and perpendicularly to the axis of revolution or the plane of symmetry of the chamber; the electrodes are each formed with an aperture centered on said axis or with each having its axis situated in said plane and brought to alternate dc potentials. Secondly, means are included for producing a magnetic field extending along the axis of revolution or in the plane of symmetry. (M.H.R.)

41626 IMPROVED PLASMA DEVICE AND METHOD. (to Gulf General Atomic Inc.). British Patent 1,123,205. Aug. 14, 1968. Priority date Nov. 4, 1964, United States.

This invention relates generally to methods of and apparatus for producing and manipulating electrical plasma and, more specifically, to a device in which a plasma may be produced and manipu-

lated by multipolar electric and magnetic fields and a method of producing and manipulating a plasma with such fields. (M.O.W.)

41627 HIGH-DENSITY AND HIGH-TEMPERATURE PLASMA PRODUCED BY LARGE POWER LASER. Yamanaka, Tatsuhiko; Tsuchimori, Noriyuki (Osaka Univ.). Technol. Rep. Osaka Univ., 18: 155-67(Mar. 1968).

A perspective of thermonuclear reaction was induced by a high-power glass laser and a CO_2 laser. The necessary laser energy, magnetic field, and containment time were calculated. An experiment on the production of plasma by focusing the high-power laser onto a lithium-hydride particle suspended in vacuum was performed. The ion energy was up to 330 eV, measured by the time-of-flight studies of expanding plasma. By focusing a laser beam onto a carbon plate target, the interaction of plasma with magnetic field was studied. Acceleration of plasma was observed, which may be caused by the exchange instability. This experiment can be considered as a model of solar flare. (NSA of Japan)

Stability of Plasma

41628 (UCRL-70868) DEPENDENCE OF ION CYCLOTRON INSTABILITIES ON PARTICLE DISTRIBUTION FUNCTIONS IN THE ALICE EXPERIMENT. Damm, C. C.; Foote, J. H.; Futch, A. H. Jr.; (and others) (California Univ., Livermore. Lawrence Radiation Lab.). June 21, 1968. Contract W-7405-eng-48. 21p. (CONF-680805-10). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

Measurements are given of plasma density, plasma instabilities, energy spectrum of trapped protons, and microwave heating of electrons in the Alice experiment. (M.O.W.)

41629 NEGLECTED PLASMA INSTABILITY INVOLVING BOUNCE RESONANCE. Southwood, D. J.; Dungey, J. W.; Etherington, R. J. (Imperial Coll. of Science and Tech., London). Nature (London), 219: 56-7(July 6, 1968).

Reference is made to a recent (unpublished) theoretical study of amplification of hydromagnetic waves in the magnetosphere, involving a mechanism which may need attention by designers of plasma containment devices. The instability considered is driven by a spatial gradient, and belongs to the electromagnetic micro-instability species; it appears to have been neglected hitherto. Application only to mirror geometry with axial symmetry is considered, and it is not clear how serious application to less symmetric geometries would be. The actual mechanisms of bounce resonance may involve any component of the electric and magnetic disturbance. The resonance condition, however, involves only the number of the harmonic seen by a particle, and attention is restricted to the fundamental. Typically high energy for electrons is relativistic, and attention is given to high-energy proton resonance. The great simplification resulting from axial symmetry is that a rotating frame can be used in which the wave field is static. A good approximation is obtained by treating the rotating frame as an inertial frame. (UK)

41630 DRIFT INSTABILITIES IN CONFINED TWO-COMPONENT PLASMAS. Lee, Kai Fong (Catholic Univ. of America, Washington, D. C. National Center for Atmospheric Research, Boulder, Colo.). J. Appl. Phys., 39: 3861-5(July 1968).

The stability of plasma columns having two components of different drift velocities and temperatures is studied. The plasmas possess nonuniform radial density profiles and are confined by an infinite axial magnetic field and concentric conducting cylinder. General expressions are given for the velocity thresholds, maximum unstable wavenumber, and the number of unstable modes in a system. It is seen that the instability depends on both the geometrical factors and the temperature ratio of the two components. The main features are illustrated by specializing to the case of a proton–electron plasma uniformly filling a conducting cylinder. (auth)

41631 ANISOTROPIC TEMPERATURE PLASMA INSTABILITIES. Kalman, G.; Montes, C.; Quemada, D. (Faculte des Sciences, Orsay, France. Univ. Paris, Orsay, France). Phys. Fluids, 11: 1797-1808(Aug. 1968).

An anisotropic plasma exhibits a transverse instability due to the mutual attraction of the microscopic current elements. A detailed study is made of this instability in an electron-ion plasma without any external magnetic field. The system is characterized by a temperature tensor and described by a quasi-Maxwellian distribution function. The dielectric tensor for such a system is calculated and then the dispersion relation is considered. It is found that there are two unstable modes: (i) a purely transverse mode and (ii) a coupled or transverse-longitudinal mode. The latter separates into two branches: (a) the first is an essentially unstable quasi-transverse mode, (b) the second is the quasi-longitudinal ion acoustic mode driven into instability through its interaction with the quasi-transverse mode. Growth rate, k and angular dependence, domain of instability, and polarization are analyzed in detail. (auth)

41632 OVERSTABLE MODES DUE TO RESISTIVITY GRADIENTS IN A CURRENT-CARRYING PLASMA SLAB. Pridmore-Brown, D. C. (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 11: 1789-92(Aug. 1968).

A preliminary study is made of overstable modes due to resistivity gradients in a current-carrying plasma slab. A restricted set of solutions satisfying a constant pressure assumption is found for the magnetohydrodynamic equations. These solutions turn out to be overstable in a certain range of the resistivity. (auth)

41633 EFFECT OF ELECTRON TEMPERATURE ON ABSOLUTE INSTABILITIES IN LOSS-CONE PLASMAS. Guest, G. E.; Dory, R. A. (Oak Ridge National Lab., Tenn.). Phys. Fluids, 11: 1775-7(Aug. 1968). (ORNL-P-3556).

Raising electron temperature in an infinite homogeneous plasma of electrons and hot ions tends toward stabilization of the absolute instabilities caused by a nonmonotonic or "loss-cone" distribution of ion velocities perpendicular to the external magnetic field. When the ion plasma frequency exceeds the ion gyrofrequency, this stabilization is incomplete although the residual instabilities have small growth rates and large axial wavelengths, permitting some degree of control by adjusting plasma parameters. (auth)

41634 LOW-FREQUENCY INSTABILITIES OF A HIGHLY IONIZED MAGNETO-PLASMA. Ishii, Shigeyuki (Inst. of Physical and Chemical Research, Honkomagome, Tokyo). J. Phys. Soc. Jap., 25: 535-42(Aug. 1968).

Measurements are made of the low-frequency oscillations occurring in a low-pressure helium arc plasma immersed in a magnetic field. A spectrum analyzer is employed in the frequency range below 200 kHz to study frequency spectra of signals from magnetic probes, a Rogowskii coil for the discharge current, and a monochromator selecting spectral lines of helium ions in the spatially definite regions of the plasma column. A drift mode instability arises from density inhomogeneity of the plasma in the boundary region and an ion–acoustic mode instability occurs in the central region. The two modes are coupled, presenting the spectra similar to that of frequency modulation. The relevant collision effects are negligible and the pertinent instabilities develop due to an axial electron stream. (auth)

Thermonuclear Processes

41635 LASER RAY BEAM GUN, OR CONCENTRATOR, FOR USE IN POLAR REGIONS, ACCELERATING CROP GROWTH, AND PROMOTING NUCLEAR FUSION REACTIONS. Pedrick, Arthur Paul. British Patent 1,119,948. July 17, 1968. Filed June 24, 1967.

The device described combines the rays from a plurality of lasers into a single concentrated beam. (M.O.W.)

Shielding

Refer also to abstracts 41382, 41440, and 41919.

41636 (ANL-Trans-608) TRANSMISSION OF FAST ELECTRONS THROUGH THICK LAYERS OF MATTER. Harder, Dietrich (Wuerzburg Univ. (West Germany). Naturwissenschaftliche Fakultaet). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Thesis. 148p. Dep. CFSTI.

The experimental and theoretical programs are reviewed. The details of the experimental assemblies are presented as briefly as possible, since they can be found in other papers. The theoretical part deals with an evaluation of the diffusion model and with the Monte Carlo method. Details concerning the corresponding calculation program are found in the appendix. (M.H.R.)

41637 (ORNL-4181) MODIFICATIONS OF THE POINT-KERNEL CODE QAD-P5A: CONVERSION TO THE IBM-360 COMPUTER AND INCORPORATION OF ADDITIONAL GEOMETRY ROUTINES. Solomito, E.; Stockton, J. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 243p. Dep. CFSTI.

The point-kernel code QAD-P5A, used for both neutron and gamma-ray shield penetration calculations, has been converted to FORTRAN IV language for use on the IBM 360/75 computer. The code has also been modified to use the generalized geometry subroutines of the 05R code, as well as special 05R subroutines

for cylindrical and spherical geometries. With the increased speed of the IBM-360 computer and the ability of the generalized geometry to describe arbitrary shapes, the versatility of the code has been increased. Another modification has been the addition of a lithium hydride kernel for use in neutron calculations; the kernel was obtained from moments method calculations. (auth)

41638 A CALCULATION FOR THE SHIELDING EXPERIMENT OF A VEHICLE ON THE INFINITE SURFACE CONTAMINATED WITH RADIOACTIVE MATERIALS. Urai, Tatsuo. Hoken Butsuri, 2: 155-9(Dec. 1967). (In Japanese).

A method for simulating the effect of radiation at a certain point inside of a vehicle originating from an infinite surface contaminated uniformly with the radioactive material, has been studied. On the circumference of radius of about the length of a vehicle, a pole is set on which radioactive sources are distributed depending upon the distribution function calculated in this paper. The dose rates of radiation at the same point are measured in the both cases: one is inside the vehicle and the other without the vehicle and the ratio between both cases was calculated, which indicates the shielding coefficient. An experimental example has also been made using a special vehicle. The shielding coefficient of this vehicle was about 6%. (NSA of Japan)

41639 PERTURBATION OF THE RADIATION FIELD BY LOCAL INHOMOGENEITY. Kol'chuzhkin, A. M.; Uchaikin, V. V. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 129-31(1968). (In Russian).

On the basis of the kinetic equation of the transmission of radiation through a homogeneous absorbing layer with plane boundaries, the effect of density changes of the layer on the detector readings was examined. An expression was derived to express the transmission in a homogeneous layer of differing density, making it possible to calculate the equation for small perturbances; a similar relation was obtained for the reflected radiation. It was found that the integral at the two limiting planes, resulting from density changes at a given point, is independent of the location of that point; it may be calculated on the basis of the relation of the unperturbed functional with the thickness of the barrier. Experimental data are available for γ quanta and neutrinos. The formula obtained may be used for solving problems encountered in radiation flaw detection and shielding. (TTT)

Solid-State Physics

Refer also to abstracts 40511, 41132, and 42103.

41640 (BNL-12559) PROPOSED REPORT OF INTERNATIONAL UNION OF CRYSTALLOGRAPHY COMMISSION ON CRYSTALLOGRAPHIC APPARATUS SINGLE CRYSTAL INTENSITY PROJECT. I. INTEREXPERIMENTAL AGREEMENT. Abrahams, S. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Hamilton, W. C. (Brookhaven National Lab., Upton, N. Y.); Mathieson, A. McL. (Commonwealth Scientific and Industrial Research Organization, Clayton (Australia). Div. of Chemical Physics). [1968]. 45p. (CONF-680619-1). Dep. CFSTI.

From Meeting on Accurate Determination of X-Ray Intensities and Structure Factors, Cambridge, England.

Sixteen laboratories have measured 7146 individual structure factors with ($\sin\theta/\lambda \leq 0.5$ Å^{-1}), using crystals of D(+)-tartaric acid grown from a single batch. All current diffractometer methods are represented in this project. The instruments included 4-circle, normal beam, and equi-inclination diffractometers. Unfiltered, singly filtered, balanced-filtered, and crystal-monochromatized CuK or MoK radiation were used. A conventional analysis of variance treatment indicates that there are significant differences among the results of seventeen experiments; these differences are manifested in highly significant systematic errors that are correlated with scattering angle, with intensity, and with the three Miller indices. The average interexperimental agreement is 8.7% for all experiments: excluding the two that differ most from the average, the agreement becomes 6.1%: a modal group of five experiments has an interexperiment agreement of 4.1%. Several common sources of error have been tentatively identified, including improper diffraction geometry, absorption, non-monochromaticity, counting losses and extinction. There was no indication that any one diffractometer method or type of instrument was better than any other. Although the results may not be typical for diffractometer data on organic crystals, they strongly suggest that systematic errors —leading possibly to results of high precision but of low accuracy —are not uncommon in single crystal structure investigations. (auth)

41641 (COO-1054-32) ELECTRON PARAMAGNETIC RESONANCE STUDIES OF RADIATION EFFECTS IN SOLIDS AND CHEMICAL COMPOUNDS. Technical Progress Report, June 1, 1967-May 31, 1968. Kim, Yeong Wook (Wayne State Univ., Detroit, Mich. Dept. of Physics). May 31, 1968. Contract AT(11-1)-1054. 26p. Dep. CFSTI.

Investigations were made on the following three groups of materials: (1) alkali metal halides, (2) phosphorus materials, and (3) superconducting materials. The samples employed in the first two groups were in the form of single crystals, while those for the third group were thin films. The samples were irradiated in beams of x rays, electrons, gamma rays, and neutrons for varying dosage at temperatures controlled near 300 or 77°K. Results are summarized. (M.O.W.)

41642 (COO-1197-31) CRYSTAL FIELD EFFECTS ON F CENTER WAVE FUNCTIONS IN KCl, CsF, AND MgO. Taylor, Lyle H.; Friauf, Robert J. (Kansas Univ., Lawrence). June 1968. Contract AT(11-1)-1197. 4p. (CONF-680902-1). Dep. CFSTI.

For Presentation at International Symposium on Color Centers in Alkali Halides, Rome, Italy.

Investigations of the interaction between an F-center electron and the core electrons of neighboring ions in the crystal are reported. A pseudopotential is obtained for each ion from free ion wave functions, and the superposition of potentials is expanded around the vacancy in Kubic harmonics. Numerical wave functions are obtained for the spherical part of the expansion, and the crystal field effects of the first nonspherical terms are obtained by perturbation theory to first order in wave functions and third order in energy. (M.H.R.)

41643 (COO-1198-551) HIGH PRESSURE MOESSBAUER STUDIES OF THE ELECTRONIC STATES OF IRON COMPOUND. Lewis, George Kenneth (Illinois Univ., Urbana. Materials Research Lab.). June 1968. Contract AT(11-1)-1198. 163p. Dep. CFSTI.

Thesis.

The Moessbauer effect was used as a probe to investigate the electronic structure of some iron compounds as a function of pressure. In four substances, the electronic structure was investigated as a function of temperature and pressure. The experimental apparatus necessary to conduct these investigations was constructed. The compounds studied were $FeCl_3$, $FeBr_3$, $KFeCl_4$, basic ferric acetate, Fe in silicate glass, Fe in phosphate glass, $Fe_2(CO)_9$, and $Fe_3(CO)_{12}$. A pressure-induced ferric to ferrous transition was studied in $FeCl_3$, $FeBr_3$, $KFeCl_4$, and basic ferric acetate. The effect of pressure of the metal ligand wavefunction overlap has been calculated and a possible mechanism for electron transfer is postulated. The effect of temperature on the reduction of the above compounds was also studied. The electronic structure of ferric and ferrous ions in sodium silicate and sodium phosphate glass as a function of pressure was studied. In phosphate glass a pressure-induced reduction of ferric iron was noted and found to correlate with the compounds mentioned above. The iron carbonyls, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$ were investigated. Evidence for the structure of $Fe_3(CO)_{12}$ is presented. (auth)

41644 (INP-570/PS) MATERIALY V ZIMOWEJ SZKOLY FIZYKI. POLANA GLODOWKA, STYCZEN-LUTY 1967. (Lectures of the V Winter Session of the School of Physics, January-February 1967). (Institute of Nuclear Physics, Krakow (Poland)). 1967. 100p. (In Polish). Dep.

Condensations of the lectures given at the 5th Winter School of Physics held at Polana Glodowka in the Tatra Mountains in January and February 1967 are presented. The school was devoted mainly to some aspects of the magnetic properties of solids investigated by slow-neutron-scattering, Mössbauer-effect, and gamma-ray angular correlation methods. (auth)

41645 (INR-890) SIMPLE DEFECTS IN GERMANIUM CREATED BY HIGH-ENERGY ELECTRONS. Rzewuski, Henryk (Institute of Nuclear Research, Warsaw (Poland)). 1968. 64p. (In Polish). Dep.

The properties of simple defects in the crystal lattice of n-type germanium created by 1-MeV electrons from the Van de Graaff electrostatic accelerators using dc and pulsed beams were investigated. In particular, fast processes of metastable defect annealing and their temperature dependence were analyzed by the method of concentrational annealing, and the charge state of simple defects above the annealing threshold of metastable defects was studied by the method of Hall mobility annealing. The measurements were carried out in the temperature range from 80 to about 200°K. It was found that for antimony-doped germanium in the temperature range from 100 to 120°K a process of fast annealing of metastable defects takes place. The activation energy $E'_R = 0.140$ eV for this process differs considerably from the energy expected in the present model by MacKay and Klontz. A proposed new model of metastable defects based on the properties of

doubly charged centers takes these results into account. By studying the charge state of simple defects with the method of isochronal annealing of Hall mobility, two new annealing thresholds at $T_1 = 100°K$ and $T_2 = 140°K$ were observed. The main annealing threshold at $T_2 = 140°K$ is connected with the process of rearrangement of simple defects. In this process the transition from one doubly charged center to two singly charged centers takes place. This indicates that the defect centers in the investigated temperature region /T < 140°K/ are doubly charged centers. (auth)

41646 (IS-T-226) GENERALIZED SUSCEPTIBILITIES AND MAGNETIC ORDERING OF HEAVY RARE EARTHS. Evenson, William Edwin (Ames Lab., Iowa). May 1968. Contract W-7405-eng-82. 91p. Dep. CFSTI.

Thesis.

Within the framework of Ruderman–Kittel–Kasuya–Yosida indirect-exchange interaction theory, the generalized susceptibilities, $\chi(q)$, were calculated for the heavy rare-earth metals, Gd, Dy, Er, and Lu, along the line Γ to A of the Brillouin zone. The energy bands used in this calculation were realistic bands obtained by Keeton and Loucks using the relativistic-augmented-plane-wave method. The matrix elements involved in the susceptibilities were taken to be constants so that the susceptibilities calculated contain only information from the energy bands. To develop a reliable numerical procedure, two sets of energy bands were examined in detail which could be calculated analytically as well as numerically. These bands were chosen to give spherical and cubic Fermi surfaces. The results obtained from them showed how to eliminate any spurious features in the susceptibilities arising from the numerical calculation, and once these spurious features were removed, these special bands demonstrated that the numerical procedures were quite reliable. Cubic and spherical Fermi surfaces were chosen because they illustrate two extremes in the features of the susceptibilities: the cubic surface has many points separated by the same wave vector, Q, so there is "nesting" of areas of the Fermi surface for q = Q; the spherical surface has only point to point nesting for any particular q. The nesting of areas results in a logarithmic divergence in the susceptibility, whereas the nesting of lines or points results only in a general falling off of the susceptibility. This fact is clearly illustrated in our two special cases. It is also possible to relate the features of the susceptibilities calculated for the rare earths to the geometries of their Fermi surfaces in the same way. This was done, and the maxima of the calculated susceptibilities were related to the magnetic ordering periodicity observed experimentally for each of the metals considered. The agreement between theory and experiment was found to be quite satisfactory. (auth)

41647 (KFKI-16/1968) ^{63}Cu NMR IN ELASTICALLY DEFORMED COPPER FOILS. Tompa, K.; Toth, F.; Nagy, E. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). June 11, 1968. 8p. Dep.

The ^{63}Cu NMR spectrum parameters are, within the experimental accuracy, the same for the undeformed as for the samples stretched in the $\langle 100 \rangle_{av}$ direction up to the elastic limit. The data were taken on a copper foil of cubic texture, characterized by an average deviation of about 6.5 degrees. Results, together with the application of the Sholl theory of the quadrupole effect in metals, give an upper limit for the antishielding of factor $(1-\gamma_\infty)$. (auth)

41648 (N-68-21124) OPTICAL ABSORPTION IN FUSED SILICA DURING TRIGA REACTOR PULSE IRRADIATION. Gagosz, R.; Waters, J.; Douglas, F. C.; De Crescente, M. A. (United Aircraft Corp., East Hartford, Conn.). Apr. 1968. Contract NASw-847. 67p. (NASA-CR-1031; F-910485-1). CFSTI.

An experimental investigation was conducted to determine the spectral transmission characteristics of fused silica before, during and after exposure to reactor irradiation pulses. The transmission measurements were carried out at three wavelengths (0.215, 0.625 and 1.0 microns) and at a range of temperatures from ambient to 900°C. Corning 7940 fused silica specimens in a corner cube configuration were mounted next to the reactor core face. Peak neutron and gamma fluxes obtained from this reactor were approximately 5.4×10^{15} n/cm^2-sec and 6.1×10^7 R/sec, respectively. Neutron and gamma doses associated with these pulses were 2.3×10^{14} n/cm^2 and 2.6×10^6 R, respectively. The effective time of the pulse obtained by dividing the total dose by the peak flux was approximately 0.043 sec. The transmission measurements were made immediately before, during and after the reactor pulses to monitor both the creation of irradiation-induced absorption and the decay of the induced absorption after the pulse. (auth)

41649 (NRC-TT-1311) ELECTRON SPIN RESONANCE IN ALKALI HALIDE CRYSTALS CONTAINING SULFUR AND SELENIUM. Hausmann, A. Translated by D. A. Sinclair for National Research Council of Canada, Ottawa, from Z. Phys., 192: 313-28 (1966). 15p. Dep. CAN.

The ESR of KCl and KBr single crystals doped with KSH or KSeH is investigated at low temperature. In these crystals interstitial hydrogen atoms are produced by irradiation with ultraviolet light at 20°K. After annealing to 110°K for some seconds and recooling to 20°K, the crystals show the resonance spectra of sulfur and selenium centers which are ascribed to S^-, H_2S^-, and Se^- ions. For verifying the nature of the centers crystals with KSD as well as KSH, the sulfur being enriched by S^{33} isotope, are studied. The components of the g and A tensors are determined. Two new types of sulfur centers are found in sulfide-doped crystals after introduction of F centers followed by irradiation with ultraviolet light at 370°K. Furthermore, all crystals being investigated reveal the ESR and HCN^- ions. (auth)

41650 (NYO-3798-2) COMPUTER CURVE FITTING OF MOESSBAUER SPECTRA USING ALGOL WITH COMPUTER TIME-SHARING SYSTEM. [May, Leopold; Druck, S. J.; Sellers, Martha] (Catholic Univ. of America, Washington, D. C. Dept. of Chemistry). July 1, 1968. Contract AT(30-1)-3798. 20p. Dep. CFSTI.

A computer program (MOSSL) which fits a series of Moessbauer peaks (Lorentzians) superimposed upon a base-line parabola by the method of minimizing the value of the sum-squared residuals of deviations. The data involve the number of counts collected on each of 200 channels of the multichannel analyzer of a Moessbauer spectrometer. The program is written in DARTMOUTH–ALGOL for use on the time-sharing system CEIR. (B.G.D.)

41651 (SC-DC-68-2328) ELECTRICAL PROPERTIES OF NEUTRON-IRRADIATED SILICON AT 76°K: HALL EFFECT AND ELECTRICAL CONDUCTIVITY. Stein, Herman J. (Sandia Corp., Albuquerque, N. Mex.). June 1968. Contract AT(29-1)-789. 32p. (CONF-680708-1). Dep. CFSTI.

From Conference on Space and Nuclear Radiation Effects, Bozeman, Mont.

Defects produced in p-type silicon by neutron irradiation were investigated using electric conductivity and Hall effect measurements at 76°K. Samples from crucible-grown (1, 10, and 50 ohm-cm) and float-zone (10 ohm-cm) boron-doped silicon were irradiated at 76°K with nearly fission-spectrum neutrons and annealed isochronally between 76 and 700°K. The electrical properties of neutron-irradiated p-type silicon exhibit an illumination dependence similar to that observed previously in n-type silicon and attributed to the presence of defect clusters. Therefore, neutron-produced changes in the electric properties of p-type silicon also are attributed to defect clusters. The sensitivity to illumination was observed for all resistivities and for both crucible and float-zone p-type silicon. The illumination-induced conductivity decays slowly with time at 76°K and influences the thermally produced changes in the electrical properties upon annealing for temperatures up to 150°K. Neutron-produced changes in the electrical properties measured after annealing to 150°K are found to be qualitatively consistent with an insulating void model for cluster-space-charge regions. The best modeling of the experimentally observed changes is for the 50 ohm-cm (large void volume) silicon. The annealing loss of the light sensitive defects occurs in diffuse stages between 150 and 550°K with the largest stage between 150 and 240°K. A major fraction of the hole mobility annealing parallels that for the light-sensitive defects and suggests that the mobility change is caused primarily by defect clusters. The most apparent crystal growth dependent annealing is observed between 540° and 620°K where a reverse annealing occurs in the hole removal rate for crucible-grown but not for float-zone silicon. The fractions of the neutron-produced decrease in hole concentration and mobility which remain after 700°K annealing are respectively ~0.1 and 0.01 for float-zone and ~0.25 and 0.1 for crucible-grown 10 ohm-cm silicon. (auth)

41652 (UCRL-50439(Pt.1)) ON THE ANOMALOUS DIFFRACTION OF X RAYS THROUGH PERFECT CRYSTALS. Schroeder, R. C. (California Univ., Livermore. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 11p. Dep. CFSTI.

A review of x-ray diffraction is given, and anomalous transmission of x rays is discussed. The subject matter is treated in four parts with part I covering a brief review of geometry and essentials followed by an outline of Ewald's derivation of the dispersion equations for x-ray diffraction as described by the dynamical theory. (auth)

41653 (UCRL-Trans-10251) STUDIES OF LATTICE DEFECTS IN NEUTRON-IRRADIATED LITHIUM FLUORIDE. Peisl, Hans. Translated by Benjamin Thayne for Univ. of California, Lawrence Radiation Lab., Livermore, from Z. Angew. Phys., 14: 529-36(1962). 31p. Dep. CFSTI.

Simultaneous x-ray and optical measurements were used to investigate the cause of the lattice expansion and its quantitative relation to the defects created. (M.O.W.)

41654 (UUIP-582) PARAMAGNETIC CENTERS IN TIN-DOPED GALLIUM PHOSPHIDE. Brizzi, J.; Haraldson, S.; Ribbing, C-G (Uppsala Univ. (Sweden). Inst. of Physics). Apr. 1968. 16p. Dep.

Electron-spin-resonance measurements at 77 and 4.2°K on Sn-doped GaP crystals are reported. Fe^{3+} impurities were identified from a 5-line spectrum with g = 2.023 and crystalline field splitting parameter a = 389 × 10^{-4} cm^{-1}. Furthermore two strong isotropic lines with g = 1.998 and g = 2.130 were detected. The first line is attributed to an Sn donor, and the possible causes of the second one are discussed. (auth) (Sweden)

41655 PHOTOSTIMULATED EXOEMISSION OF ELECTRONS FROM NaCl AND KCl CRYSTALS EXCITED BY IRRADIATION WITH ELECTRONS. Sujak, B.; Gajda, R. (Wroclaw Univ.). Acta Phys. Pol., 33: 853-63(May 1968).

The kinetics of photostimulated exoemission from the surface of NaCl and KCl single crystals excited by electrons is studied. The influence of exciting-electron energy, external electric field, intensity of light, and sample polarization time on the emission kinetics is shown. (auth)

41656 TRIBO-PHOTOSTIMULATED EXOEMISSION OF ELECTRONS AND TRIBOLUMINESCENCE OF COLOURED NaCl SINGLE CRYSTALS. Pirog, M. (Higher Pedagogical Coll., Opole, Poland); Sujak, B. Acta Phys. Pol., 33: 865-73(May 1968).

Photostimulated exoemission of electrons and luminescence during deformation of sodium chloride single crystals has been investigated. The investigations have been carried out at various rates of the compressive force increase. The samples used in the investigations were previously colored by x rays. It has been found that during plastic deformation and at the force increase rates used in the experiment there is a rigorous correlation between the total number of electrons emitted by the sample and the total amount of luminescent light. When the total number of emitted electrons increases at a fixed force growth rate, the total amount of luminescence decreases. (auth)

41657 USE OF THE MICROHARDNESS METHOD FOR THE STUDY OF THE EFFECTS OF RADIATION ON THE PREHARDENING RANGE OF CRYSTALS. Boyarskaya, Yu. S.; Zhitaru, R. P. Zavod. Lab., 34: 597-8(1968). (In Russian).

The possibility of using the microhardness method for the study of the effects of different types of irradiation on solids hardened by plastic deformation was shown. It was established that x radiation causes a supplementary increase of the microhardness of the area prehardened by plastic deformation. Areas undergoing very strong hardening were hardened less during irradiation than weakly hardened areas. (tr-auth)

41658 LOW-ENERGY ELECTRON DIFFRACTION STUDIES OF URANIUM DIOXIDE. Ellis, W. P. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 48: 5695-5701(June 15, 1968).

The (110), (111), and (100) surfaces of uranium dioxide have been studied by low-energy electron diffraction. Below 600°C the (110) face displays persistent fractional-order beams characteristic of contamination, and at higher temperatures in vacuum thermal faceting occurs. The (111) surface interacts with O_2 at room temperature to produce rings around the integral-order beams, and if this surface is mechanically disrupted fractional-order arrays are formed in the interval 200° to 390°C. For UO_{2+x}(111) at all temperatures the most characteristic diffraction features are also rings around the integral-order reflections; fractional-order beams are observed from UO_{2+x}(111) only if the surface is disrupted. It is postulated that rings display a disordered U_4O_9 substructure which consists of clusters of two or three adjacent atoms occupying regular lattice sites, but separated from neighboring clusters by approximately three lattice spacings; it is further postulated that surface discontinuities act as sources of mobile species which migrate across the surface and in the presence of oxygen condense out as higher oxides in fractional arrays. The (100) surface is stable with respect to faceting up to at least 1600°C SBT, and apparently does not react with O_2 to produce rings or fractional-order beams in the diffraction pattern. (auth)

41659 MECHANISM OF THE COLORATION OF KCl(Ca) CRYSTALS EXPOSED TO X RADIATION. Voszka, Rudolf (Inst. of Medical Physics, Budapest). Fiz. Szemle, 18: 185-7 (June 1968). (In Hungarian).

It has been noted that alkali metal halides containing bivalent ion impurities are more strongly colored during the initial stages of exposure to ionizing radiation than pure crystals. The mechanism involved in this phenomenon was studied on the KCl(Ca) system, growing the crystals from raw materials purified by zone melting to which 0.1% of $CaCl_2$ was added. The crystals were subjected to measurement of the light absorption, electron spin resonance, and ionic thermocurrent. On the basis of the results, the following mechanism is proposed: the V_1^M center is formed by the association of two V_K^M centers, according to which there are two F centers for each V_2^M center. The V_2^M center may be considered as a Cl_2^- molecular ion, occupying two cation and one anion lattice vacancies. The local neutrality is ensured by the presence of the two Ca^{2+} ions. (TTT)

41660 MOESSBAUER STUDIES OF ALNI ALLOY. Albanese, G. (Univ., Parma, Italy); Asti, G.; Musci, M.; Criscuoli, R. Z. Angew. Phys., 25: 62-5(July 1968).

The Mössbauer techniques were applied to investigate the chemical composition and magnetic properties of the individual phases in Fe-Ni-Al alloy of the "Alni" type. In our samples, after optimum coercivity treatment as well as after quenching from 1260°C followed by aging at different temperatures, the fraction of iron in paramagnetic surrounding was always substantially lower than predicted by the Bradley's phase diagram. The theoretical values of magnetization σ are in agreement with the experimental curve of σ v.s. aging temperature. Disagreement between the predicted and observed behavior of the intrinsic coercive field as a function of aging temperature, suggests the presence of an additional source of anisotropy besides shape and magnetocrystalline anisotropy. Some results with samples aged at 300°C, where the decomposition was stopped at various stages, seem to be inconsistent with the hypothesis of the spinodal decomposition. (auth)

41661 CRYSTAL FIELD EFFECTS ON THE INELASTIC NEUTRON SCATTERING FROM HEAVY RARE EARTH METALS IN THE PARAMAGNETIC PHASE. Woods, A. D. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 46: 1499-1501(June 15, 1968). (AECL-3103).

Expressions which arise in the interpretation of inelastic neutron scattering from hexagonal close packed rare earth metals in the paramagnetic phase are presented and discussed. It is concluded that the fourth- and sixth-order terms which occur in the Hamiltonian describing the crystal field can, in some cases, be as important as the leading second-order term. (auth) (Canada)

41662 STUDY OF RADIATION RESISTANCE OF BeO AT 100°C. Khudyakov, A. V.; Marakueva, N. A.; Klimenkov, V. I.; Balandin, G. S. At. Energ. (USSR). 24: 483-5(May 1968). (In Russian).

Radiation resistance of beryllium oxide specimens of various shapes and dimensions was studied. Microstructure of specimens irradiated with neutron flux up to 4 × 10^{21} n/cm^2 showed that fine-grain material exhibited better radioresistance. Also, it was shown that various additions of impurities improved the resistance of BeO. The analysis indicates a higher damage at the grain boundary in polycrystalline material. It is suggested that smaller-grain material with plastic interlayers would exhibit a higher radiation resistance. (R.V.J.)

41663 SURFACE PROPERTIES OF OXIDIZED SILICON. Kooi, E. New York, Springer-Verlag New York, Inc., 1967. 142p. $5.40.

Thesis.

A separate abstract was prepared for Chapter 5. Chapter 6 (Effects of Ionizing Irradiations on the Properties of Oxide-Covered Silicon Surfaces) was previously abstracted and appeared in NSA as 20: 7647. (W.D.M.)

For an abstract of the individual paper see: 41208.

41664 ELECTRON SPIN RESONANCE STUDIES OF VANADATE, NIOBATE, PHOSPHATE, AND ARSENATE IN GAMMA-IRRADIATED CALCIUM MOLYBDATE AND CALCIUM TUNGSTATE. Edwards, P. R.; Subramanian, S.; Symons, M. C. R. (Univ. of Leicester, Eng.). Chem. Commun. No. 14: 799(July 17, 1968).

The hole centre formed on γ irradiation of $CaWO_4$ at 77°K was found to have ESR properties in accordance with expectation for WO_4^-, although there is some evidence that the electron deficiency is shared with an adjacent anion, and it was suggested that the analogous species MoO_4^- is formed in $CaMoO_4$. Traces of VO_4^{2-}, NbO_4^{2-}, PO_4^{2-}, and AsO_4^{2-} resulted in almost complete replacement of the W or Mo centres by impurity-associated centres. In some cases the magnetic centres produced by γ irradiation reflected the tetragonal symmetry of the matrix material, while in other instances only a single magnetic site could be detected. The latter situation could be produced from the former by warming, and the change was reversible. This effect, which could be achieved either by a mobile distortion or by some form of rotation, may be associated with the occasional appearance of satellite lines at 77°K, believed to be superhyperfine structure

arising from weak interaction with neighbouring WO_4^{3-} or MoO_4^{3-} ions (ESR results for the tetroxy-anion radicals VO_4^{4-}, NbO_4^{4-}, and MoO_4^{-} in $CaMoO_4$ matrix, and PO_4^{4-}, AsO_4^{4-}, and WO_4^{-} in $CaWO_4$ matrix are presented). It is suggested that VO_4^{4-}, NbO_4^{4-}, PO_4^{4-}, and AsO_4^{4-} are formed by transfer of an electron from the parent ion to either WO_4^{-} or MoO_4^{-} produced initially by the radiolysis. It is indicated that in all cases the orbital of the unpaired electron is entirely on oxygen, the coupling to the central atom being largely a consequence of spin polarisation of the σ electrons. The highest occupied level of the parent diamagnetic ion is therefore associated with oxygen. An interesting link may thus be provided between tetroxy anions of the nontransition and transition elements. (UK)

41665 MAGNETIC SUSCEPTIBILITY OF PuO_2. Raphael, G.; Lallement, R. (CEN, Fontenay-aux-Roses, France). Solid State Commun., 6: 383-5(June 1968).

The magnetic susceptibility of $PuO_{2.00}$ was measured from 4 to 1000°K. The susceptibility is constant and equal to 536 emu/mole. It is considered that the type of magnetism is a Van Vleck paramagnetism, due to the excitation between the γ_1 and γ_4 levels from the $5I_4$ multiplet under the action of the crystal field of the oxygen ions. (auth) (UK)

41666 MAGNETIC SUSCEPTIBILITY OF NEODYMIUM HEXABORIDE. Hacker, H. Jr. (Duke Univ., Durham, N. C.); Lin, M. S. Solid State Commun., 6: 379-81(June 1968).

Measurements of the magnetic susceptibility of NdB_6 are reported for temperatures between 4 and 250°K. The results indicate that the compound undergoes an antiferromagnetic-to-paramagnetic transition at $T_N = 8.45$°K. The mass susceptibility at T = 298°K was determined to be $\chi_m = 23.8 \times 10^{-6}$ emu/g, while the value at $T_N = 8.45$°K was 178.0×10^{-6} emu/g. (auth) (UK)

41667 HIGH-FREQUENCY SPECIFIC HEAT MEASUREMENTS AND EXCHANGE CONSTANTS OF $GdCl_3$. Clover, R. B.; Wolf, W. P. (Yale Univ., New Haven). Solid State Commun., 6: 331-4(June 1968).

Improved high-frequency susceptibility experiments were performed to determine the magnetic specific heat C_M of $GdCl_3$ at 77° and 20.4°K. The results are compared with an extrapolation of calorimetric measurements below 4.2°K and a high-temperature calculation using the exchange constants J_{nn} and J_{nnn} derived from EPR measurements on Gd–Gd pairs. Correlating all results leads to an unambiguous choice for the two Heisenberg exchange interaction constants. (auth) (UK)

41668 MAGNON ENERGIES AND EXCHANGE INTERACTIONS IN TERBIUM. Houmann, J. C. Gylden (Research Establishment Risoe, Roskilde, Denmark). Solid State Commun., 6: 479-84(July 1968).

The magnon density of states, and hence the magnetic contribution to the specific heat, and also the exchange interaction between ions in the same sublattice, were calculated for Tb at 90°K, using experimental results obtained by inelastic neutron scattering. (auth) (UK)

41669 THE SPECIFIC HEAT OF Gd-DOPED EuS. Moruzzi, V. L.; Teaney, D. T.; van der Hoeven, B. J. C. Jr. (IBM Watson Research Center, Yorktown Heights, N. Y.). Solid State Commun., 6: 461-4(July 1968).

The magnetic specific heat of Gd-doped EuS was found to be broadened and shifted to higher temperature. Up to 50°K the energy increases and the entropy decreases. The results are compared with Kasuya's cluster model (to be published). (auth) (UK)

41670 FORMATION AND BLEACHING OF X-RAY-INDUCED F CENTERS IN CaF_2. Arends, J. (Princeton Univ., N. J.). Solid State Commun., 6: 421-3(June 1968).

Results are presented on the formation and optical bleaching of x-ray-induced F centers in CaF_2 at liquid nitrogen temperature. The data indicate that the F-center vacancies are created by the irradiation. After optical bleaching the vacancies can easily be refilled with electrons. A possible model for the absorption band at 225 nm is discussed. (auth) (UK)

41671 DETERMINATION OF THE DEBYE TEMPERATURE OF SnTe USING THE MOESSBAUER EFFECT IN ^{119}Sn AND ^{125}Te. Bukshapan, S. (Soreq Nuclear Research Center, Yavne, Israel). Solid State Commun., 6: 477-8(July 1968).

The temperature dependence of the recoilless fraction in SnTe was measured for ^{119}Sn and ^{125}Te nuclei in the range 85° < T < 250°K. Assuming a Debye model for the recoilless fraction, the Debye temperatures for both cases were evaluated. The results are $\theta_M(^{119}Sn) = 132 \pm 3$°K, $\theta_M(^{125}Te) = 141 \pm 5$°K, in agreement with the Debye temperatures determined from specific heat measurements. (auth)

41672 RECOMBINATION CENTERS IN γ-RAY IRRADIATED BORON DOPED P-TYPE Si. Nakashima, Kenshiro; Inuishi, Yoshio (Osaka Univ.). Jap. J. Appl. Phys., 7: 965-6(Aug. 1968).

It has been shown previously that recombination centers responsible for recombination at around room temperature consist of two kinds of radiation defects: an A center and an $E_v + 0.3$ eV center. Additional experimental results which confirm this conclusion are presented. (M.H.R.)

41673 CURRENT OSCILLATIONS IN NEUTRON-IRRADIATED GALLIUM ARSENIDE. Vodop'yanov, L. K.; Kurdiani, N. I. (Inst. of Semiconductor Devices, Tbilis USSR). Soobshch. Akad. Nauk Gruz. SSR., 49: 49-53(1968). (In Russian).

Unalloyed, n-type specimens of GaAs, with a carrier concentration of $n = 2 \times 10^{17}$ cm^{-3}, specific resistivity $\rho = 9 \times 10^{-3}$ ohm cm, and mobility $\mu = 3 \times 10^3$ cm^2 v^{-1} sec^{-1} at 77°K were irradiated at the central beam hole of the reactor, at a point of highest fast-neutron concentration. They were protected against the effect of slow neutrons by enclosing them within a 1-mm-thick cadmium foil. After exposure to integral fluxes of 10^{19} to 10^{20} n cm^{-2}, the specific resistivity increased to 2.2×10^8 to 8.4×10^{11} ohm at 77°K. Application of a stationary electric field to the high-resistance specimens resulted in the generation of low-frequency oscillations; exposure to white light increased considerably the amplitude of these oscillations, while increasing the temperature to room temperature decreased the amplitude. The highest intensity of the nonstationary current was noted at specific resistivities of 10^8 to 10^9 ohm cm; therefore the high-resistivity specimens were annealed after irradiation to reduce their resistivity. From the results it was concluded that disordered regions play an important role in the formation of spatial regions in neutron-irradiated gallium arsenide. These regions and charged layers may act as "seeding" areas of nonhomogeneity in the system. The effect of high-temperature annealing indicated that the current oscillation effects are due to radiation defects in the crystals. (TTT)

41674 THERMOLUMINESCENT STUDY OF X-IRRADIATED POLYCRYSTALLINE CaO, SrO, AND BaO. Taylor, E. D. (Texas Technological Coll., Lubdock); Hecht, H. G. Contract W-7405-eng-36. J. Phys. Chem. Solids, 29: 865-7(May 1968). (LA-DC-8898).

The results are reported of an extension of the authors' former study of MgO [J. Phys. Chem. Solids, 28: 1599(1967)] to CaO, SrO and BaO, using techniques identical to those formerly described. The glow curves for the respective polycrystalline samples are given, no foreign ions being intentionally added. An analysis of the thermoluminescent glow curves suggested that the kinetics tended to change from first order to second order in passing to heavier alkaline earth oxides, the kinetics of MgO being first order. (UK)

41675 NEGATIVE-ION VACANCIES IN IRRADIATED MgO. Chen, Y. (Oak Ridge National Lab., Tenn.); Sibley, W. A.; Srygley, F. D.; Weeks, R. A.; Hensley, E. B.; Kroes, R. L. Contract W-7405-eng-26. J. Phys. Chem. Solids, 29: 863-4 (May 1968). (ORNL-P-3409).

It has been claimed, on the basis of optical and ESR data obtained on neutron-irradiated specimens, that the large absorption band at ~5.0 eV is due to F centers. The results of the present authors indicated that in view of the crystal purity and irradiation conditions employed, this was not the case. The attempts which were made in the past to correlate the ESR F centers produced by neutrons at about 150°C and the optical band at 5.0 eV are reviewed, and data are presented which indicated that this apparent correlation is not valid for all crystals or irradiation conditions. (UK)

41676 MAGNETIC DAMPING IN TERBIUM. Burdett, C. F. (Univ. of Strathclyde, Glasgow); Layng, R. B. J. Phys., D, 1: 1005-9(Aug. 1968).

The variation of internal friction with strain amplitude of terbium at temperatures of 113, 155, 181, and 298°K was measured, using a torsional pendulum at a frequency of 1 Hz. The damping with magnetic origin was separated from the total damping by a method due to Granato and Lücke (1956), and the results explained in terms of the irreversible movement of domain boundaries. (auth) (UK)

41677 CONDUCTIVITY AND CARRIER CONCENTRATION IN SILICON DOPED BY MEANS OF ION BOMBARDMENT. Galaktionova, I. A.; Gusev, V. M.; Naumenko, V. G.; Titov, V. V. Fiz. Tekh. Poluprov., 2: 787-91(June 1968). (In Russian).

The carrier concentration and mobility along the thickness of the inverse layer produced by bombardment of p-type silicon by phosphorus ions at 30 keV were determined by measuring the conductivity and Hall effect during consecutive etching of five layers on the crystal surface. It was found that with an irradia-

tion dose of 5×10^3 μCl/cm^2 and annealing temperature of 600 to 700°C the ratio between the conductivity and carrier concentration is identical to that of unirradiated n-type silicon. Data obtained on the conductivity profile as a function of the mass, ion energy, radiation dose, and crystal orientation are included. (R.V.J.)

41678 PHOTOCONDUCTIVITY SPECTRA OF IRRADIATED GERMANIUM CRYSTALS. Vasil'ev, A. V.; Rybakova, L. A.; Smirnov, L. S. (Inst. of Physics of Semiconductors, Novosibirsk, USSR). Fiz. Tekh. Poluprov., 2: 904-5(June 1968). (In Russian).

Photoconductivity spectra of n-type Ge specimens alloyed with Sb ($\rho \sim 10$ ohm-cm and dislocation density $\sim 10^3$ cm^{-2}), annealed and tempered at 600 to 800°C, and irradiated with 3.5-MeV electrons at room temperature, were obtained. Data showed that with increased annealing temperature the spectra of irradiated n-type germanium approached the fundamental band, which is due to the Fermi level shift during annealing. Annealing at 600 to 800°C and irradiation by 5×10^{14} to 10^{16}/cm^2 resulted in conversion-type conductivity. Experiments showed that photoconductivity spectra of p-type Ge specimens do not differ from those of n-type specimens converted into p-type and do not change under irradiation by electron fluxes under 10^{16} e/cm^2. (R.V.J.)

41679 NIOBIUM: LATTICE PARAMETER AND DENSITY. Barns, R. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 39: 4044-5(July 1968).

In order to check the agreement to be expected between the densities of a material as calculated from hydrostatic measurements and x-ray measurements, the density of a single crystal of Nb was measured by both techniques. Values of 8.5754 ± 0.0010 and 8.58368 ± 0.00021 g/cc were obtained for the hydrostatic and x-ray measurements respectively. (A.G.W.)

41680 EFFECT OF NEUTRON IRRADIATION ON COPPER CRYSTALS AT HIGH TEMPERATURES. Hulett, L. D. Jr.; Baldwin, T. O.; Crump III, J. C.; Young, F. W. Jr. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 39: 3945-54(July 1968). (ORNL-P-3717).

Etching, x-ray topography, and electron-microscopy studies have shown that neutron irradiation at about 400°C produces a defect structure different from that produced by irradiation at ambient temperatures. On a macroscopic scale the damage was nonhomogeneous; there were regions containing high concentrations of defects separated by apparently perfect crystal. The size of the defect regions ranged from 10 to 100 μ, and the distance between regions was ~ 100 μ. Borrmann topographs showed long-range order among the defect regions in that they tended to be aligned in habit planes parallel to (111) planes. Measurements of the absolute integrated intensities of Borrmann diffracted beams indicated that there must have been a large degree of elastic strain between defect regions. It has been shown that the defect regions were aggregates of large dislocation loops 1000 to 2000 Å in diameter, dislocation tangles of roughly the same dimension, smaller loops 50 to 150 Å in diameter, and three-dimensional point defect clusters 200 Å or less in dimension. The larger loops were principally interstitial, the smaller loops were principally vacancy type. The concentration of vacancies and interstitials within defect regions, as estimated from the loops and clusters, was 1.6×10^{18}/cm^3 and 2×10^{18}/cm^3, respectively, which averaged to about 3×10^{16}/cm^3 for the entire crystal. These high-temperature irradiation effects were somewhat independent of the state of perfection of the specimens; defect regions were observed in polycrystal as well as single-crystal specimens. Annealing of the high-temperature damage occurred nonhomogeneously between 500° and 800°C, a higher range than that for annealing damage produced at ambient temperatures. Defect regions remote from as-grown dislocations were annealed at the lower temperatures, while those near dislocations required anneals at 800°C. (auth)

41681 RADIOGRAPHY OF PLATINUM BY MEANS OF CHANNELED ALPHA PARTICLES. Quere, Y.; Couve, H. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Appl. Phys., 39: 4012-14(July 1968).

Alpha particles emitted from a radioactive source and traversing a metallic foil of adequate thickness emerge only if they are channeled in the metal. They produce an image on a collector. It is shown that this image is strongly affected by lattice defects existing in the foil. Recrystallization of platinum is observed. The activation energy is measured: E = (2.85 ± 0.15) eV. Zones of enhanced channeling exist in the metal along {111} and {100} planes producing geometrical patterns on the image. (auth)

41682 LOCAL ATOMIC ARRANGEMENTS IN A NICKEL–10 ATOMIC PERCENT TUNGSTEN ALLOY. Ammons, A. M.; Spruiell, J. E. (Univ. of Tennessee, Knoxville). J. Appl. Phys., 39: 3682-9(July 1968).

The x-ray diffuse scattering from both single-crystal and polycrystalline samples of a Ni–10 at. % W alloy has been measured and interpreted to yield information about local atomic arrangements in the alloy as a function of heat treatment and cold deformation. The short-range-order parameters for a sample quenched from 950°C agreed well with those computed from a model based on long-range-ordered Ni_4W. The degree of short-range order gradually decreased as the alloy was cold worked, but could be recovered at annealing temperatures well below the recrystallization temperature. An attempt was made to use these results to explain the anomalous behavior of the electrical resistivity upon plastic deformation. (auth)

41683 FAST-NEUTRON IRRADIATION EFFECTS IN CdS. Johnson, R. T. Jr. (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys., 39: 3517-26(July 1968).

The effects of fast-neutron irradiation on the room-temperature dark resistivity and Hall mobility in CdS have been determined. Single crystals ranging from 0.5 to 10 Ω-cm and from 10^7 to 10^9 Ω-cm were irradiated in a reactor at 30° ± 5°C. For fluences of 10^{16} neutrons/cm^2 and 10^{17} neutrons/cm^2 the Hall mobility decreases by 3 to 5% and 20 to 30%, respectively. At one day after irradiation to $>10^{17}$ neutrons/cm^2, the crystals are still n-type and the resistivity approaches a limiting value of $\sim 2 \times 10^4$ Ω-cm, independent of the initial resistivity. The corresponding limiting electron quasi-Fermi level is at ~0.37 eV below the conduction band. Following irradiation, three separate time-dependent processes occur that cause changes in the resistivity. Two of these are temperature-independent and follow first-order kinetics with half-lives of ~1 and ~14 days, respectively. The third process is much slower and is temperature-dependent. The room-temperature annealing rate for this process depends on the sample and also on either the electron quasi-Fermi level or the defect concentration. Initial changes in the postirradiation resistivities are primarily results of the first two processes and are attributed to self-ionization of the sample by radioactive decay of transmuted atoms produced during the irradiation. The major radioactive decay process (14-day half-life) results from the beta irradiation from radioactive ^{32}P; the other process is tentatively identified as resulting from the ^{115}Cd beta decay. The temperature-dependent process is attributed to the annealing of radiation-induced defects, which are probably more complicated than simple vacancies or interstitials. (auth)

41684 ACCUMULATION OF F CENTERS IN X-IRRADIATED KCl FIBER CRYSTALS. Gol'denberg, S. U.; Malaev, S. M. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 1, 7-10(1968). (In Russian).

The tests were made on whiskers grown by evaporation of a saturated solution through a collodion film, and also by cleavage. A specially developed microspectrophotometric setup was used to investigate the absorption spectra produced upon exposure to x rays. Measurement of the absorption spectrum in the 400 to 860 nm region after 10 hours of exposure to x rays has shown that the irradiation produces mostly F centers. From an examination of the kinetics of the accumulation of these centers in whiskers grown by different methods and having different diameters, and particularly from the fact that the irradiation properties of whiskers grown by different methods are different, it is concluded that the mechanism of dislocation jogs on the surface of the crystals cannot be the reason for the radiation coloring of alkali-halide crystals at room temperature. Further study is necessary to determine the actual source of the F centers. (ATD)

41685 MAGNETO-ELASTIC BEHAVIOUR OF A TERBIUM SINGLE CRYSTAL. I. ANISOTROPIC SINGLE-ION PROPERTIES. du Plessis, P. de V. (Univ. of the Orange Free State, Bloemfontein, South Africa). Phil. Mag., 18: 145-56(July 1968).

The ordinary anisotropic magnetostriction of rather small terbium single crystals in the ferro, antiferro and paramagnetic regions is reported. The small specimen thickness necessitated corrections to be made which amounted to an increase in the observed magnetostriction data of 14%. The evaluation of this correction is discussed. The basal-plane magnetostriction coefficients obey the single-ion $I_{1+\frac{1}{2}}$ law (Callen and Callen 1965) over ferro and paramagnetic regions with normalization values of $\lambda^{\epsilon,2}(0)$ (= 2C(0)) = 8.5×10^{-3} and A(0) = 2.5×10^{-3}. Other coefficients could not be measured in the ferromagnetic region because a large anisotropy confines magnetic moments to the basal plane. The coefficients $\lambda^{\epsilon,2}$ and $\lambda^{\theta,2}$ were obtained in the paramagnetic region. Assuming the single-ion magnetization dependence, an extrapolation to 0°K yields the values: $\lambda^{\epsilon,2}(0) = 20 \times 10^{-3}$ and $\lambda^{\theta,2}(0) = 15 \times 10^{-3}$. (auth) (UK)

41686 MAGNETO-ELASTIC BEHAVIOUR OF A TERBIUM SINGLE CRYSTAL. II. EXCHANGE PROPERTIES. du Plessis,

P. de V. (Univ. of the Orange Free State, Bloemfontein, South Africa). Phil. Mag., 18: 157-69(July 1968).

The temperature dependence of the isotropic component of the basal-plane forced magnetostriction of terbium was measured between applied fields 17,500 to 19,500 Oe. A peak value of -18.5×10^{-9}/oersted occurs at 246°K. Exchange and ordinary magnetostriction terms contributed to yield a positive forced magnetostriction along the c axis. These terms were separated in the paramagnetic region by applying the field along b and c axes and taking into account the anisotropy in magnetization. The temperature dependence of the c axis thermal expansion coefficient is given. An anomaly is observed at 225°K, which coincides with the most recent value given for the helical-paramagnetic transition point (Dietrich and Als-Nielsen 1967). (auth)

41687 LEED OBSERVATIONS OF EPITAXIALLY GROWN THORIUM ON (100) TANTALUM. Pollard, J. H.; Danforth, W. E. (Bartol Research Foundation, Swarthmore, Pa.). J. Appl. Phys., 39: 4019-20(July 1968).

The growth of thorium overlayers on (100) tantalum at 950°C has been studied to an equivalent depth of 20 monolayers by LEED. The thorium initially forms an incomplete c(2 × 2) structure, in "island," up to a density of 3×10^{14} atoms/sq cm. Thereafter the 2D LEED pattern shows that the thorium has apparent (1 × 1) registry with the tantalum substrate up to a density of 1.8×10^{15} atoms/sq cm. The possibility of pseudomorphism is discussed. Recent electron micrographs of the surface show that thorium agglomerates in random islands after completion of the first 2D pseudomorphic monolayer. (auth)

41688 THERMAL CONDUCTIVITY OF SEMICONDUCTORS IRRADIATED BY FAST NEUTRONS AT LOW TEMPERATURES. Gusev, I. A.; Chudnovskii, A. F. (Agrophysical Inst., Leningrad). Inzh.-Fiz. Zh., 14: 1101-16(June 1968). (In Russian).

Thermal conductivity changes were induced in germanium and silicon by fast neutrons in the temperature range 5 to 300°K. It is shown experimentally that the thermal conductivity of semiconductors decreases under the action of fast neutrons. This phenomenon is essential from the point of view of elucidating the processes of dispersion and energy transfer in the crystal, as well as in the practical sense, for example, when constructing some semiconductor thermoelectric devices, one aims at decreasing thermal conductivity for the sake of increasing the efficiency of the devices. It is stated that the decrease in thermal conductivity is greater at lower temperatures at which the conductivity is studied and higher integral fast neutron flux through the material; however the flux should not exceed a certain limit for a given material. The existing models of thermal conductivity for semiconductors in the above temperature range have briefly been considered. The influence of annealing on the regeneration of disturbance defects under the neutron irradiation of germanium and silicon was investigated separately. (auth)

41689 INFLUENCE OF THE DISTORTION OF LOW-FREQUENCY MODULATION ON THE SIGNAL OF NUCLEAR MAGNETIC RESONANCE. Rakos, Matej (Vysoka Skola Technicka, Kosice, Czech.). Cesk. Cas. Fys., 18: 369-77(1968). (In Czech).

The influence of the distortion of low-frequency modulation voltage on the symmetry of records of the derivative of the absorption line of nuclear magnetic resonance and on the width of the recorded curve is discussed. This influence is investigated experimentally for the case of 89- and 30.5-Hz modulation both when the reference low-frequency voltage is undistorted and when it is distorted in the same way as the voltage applied to the modulation coils. It is found that the dependence of the asymmetry factor and the line width for the given cases differs considerably. The interpretation of the results is based on the fact that with an increase in distortion new higher harmonic frequencies are produced having different values of the frequency, amplitude, and phase shift. This conception is applied to the solution of Blochs equations for the case of several modulation frequencies and an explanation is put forward for the changes measured in the shape of the NMR absorption curve. (auth)

41690 X-RAY INDUCED PHOTOCONDUCTIVITY IN ANTHRACENE. Watanabe, Yasutaka; Saito, Nobuyuki; Inuishi, Yoshio (Osaka Univ.). Jap. J. Appl. Phys., 7: 854-61(Aug. 1968).

The photoconductivity has been studied in anthracene by irradiation with 50-kV, 0.4-μsec x-ray pulses. The temperature dependence of hole mobility can be described in terms of a multiple-trapping mechanism; $\mu_h = 3.46 \times 10^3 T^{-1.1}[1 + N_t/N_v \exp(\Delta\epsilon/kT)]^{-1}$, where $N_t = 1.4 \times 10^{17}$ cm^{-3} and $\Delta\epsilon = 0.19$ eV, while electrons represent $\mu_e = 3.6 \times 10^2 T^{-1.3}$, in the range from 316 to 238°K. The schubweg per unit is 2.6×10^{-5} cm^2/V for holes, while for electrons this value is 1.8×10^{-5} cm^2/V at room temperature. The number of collected carriers increases with temperature with the activation energies of 0.02 eV for T ≥ 270°K and of ~0.06 eV for T < 270°K where carrier recombination is predominant. It is shown that in the broad conductivity state wherein electrons have a long mean free path of ≥100 Å, the probability for escaping from the attractive coulomb field is more than 4×10^{-1}. (auth)

41691 MICROHARDNESS OF FAST-NEUTRON-IRRADIATED SILICON MONOCRYSTALS. Makarevich, A. I.; Raines, L. Yu.; Berezina, G. M.; Kurilovich, N. F. (Inst. of Physics of Solids and Semiconductors, Minsk). Dokl. Akad. Nauk BSSR, 12: 495-7 (June 1968). (In Russian).

Effects of fast neutron irradiation on the microhardness of silicon single crystals were studied at various neutron doses and temperatures. It was found that with increased neutron doses the silicon microbardness increased monotonically, reaching a saturation point. Moreover, with the temperature rise from 56° to 110°C, the saturation point of microhardness was reached at lower neutron doses. The nature of radiation defects causing the changes in silicon microhardness are postulated. (tr-auth)

41692 MANY-QUANTUM TRANSITIONS IN CONDUCTION ELECTRON SPIN RESONANCE. Koss, T. A.; Alexander, S.; Schwerdtfeger, C. F. (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 1685-9(Aug. 1, 1968).

Resonance absorption spectra were observed, which may be interpreted as many-quantum transitions where the quantization was along the effective field in the rotating frame. The spin system used was that of the conduction electrons in Li metal in a crystal of neutron-irradiated LiF. An analysis of the experimental results using a modified Bloch equation under the assumptions that $T_1 = T_2 = \tau \cong 1.5 \times 10^{-7}$ sec and that the spin system relaxes towards the instantaneous field is presented. The agreement between theory and experiment is excellent. (auth) (Canada)

41693 ELECTRON SPIN RESONANCE IN TURBOCRYSTALLINE CARBONS. I. Arnold, G.; Mrozowski, S. (State Univ. of New York, Buffalo). Carbon, 6: 243-56(May 1968).

In continuation of studies on ESR in polycrystalline graphites, experiments on temperature dependence and on the effect of neutron irradiation on the ESR for two carbon blacks, P33 and Thermax, were performed in the range of heat treatments from 1400° to 3000°C. Intensity, g-value, and line width data are reported. The results show that throughout the whole range the ESR absorption can be analyzed in terms of two components, localized spins and carrier absorption, producing a single ESR line as a result of exchange mixing of the g values. The presence of the intensity minimum observed by Castle and Wobschall was confirmed and explained as being the result of a variation in band overlap. Neutron irradiation leads to an increase in the ESR intensity, mainly through an increase in the concentration of localized spins. The stability of the so-created localized spin centers against anneal is higher in the carbons of lower heat treatment (that is for lesser organized structures). It is shown that the dependence of the room temperature g factor for the carriers (after correcting the measured values for the M effect) on the heat-treatment temperature parallels closely the variation of the diamagnetic susceptibility and also agrees well with the dependence of the g value on crystallite size L_a found in previous work for a variety of carbon blacks (heat treated to 2900°C). (auth) (UK)

41694 MECHANISM OF THE GENERATION OF RADIATION IN ELECTRON-EXCITED CADMIUM SULFIDE. Bogdankevich, O. V.; Devyatkov, A. G.; Orlov, V. S. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Semicond. (Engl. Transl.), 1: 534-40(Nov. 1967).

Properties of the spontaneous luminescence and of the stimulated radiation of CdS, emitted under the action of an intense fast-electron beam, were studied. The luminescence was excited with pulses of 50- and 200-keV electrons. The pulse duration was 0.2 μsec at 50 keV and 2.5 μsec at 200 keV; the repetition frequency was 50 cps. The current densities in the electron beam were up to 1 A/cm^2 at 200 keV and up to 6 A/cm^2 at 50 keV. The spectrum recorded at about 30°K, with an electron current density of about 750 mA/cm^2, showed clearly the blue luminescence with several narrow lines and the green luminescence with a larger number of equidistant bands. The values of the thermal quenching energy, estimated from the curves showing the temperature dependence of the integral radiation intensity in the region of the I_1 line (4888.6 Å) gave a value 0.016 ± 0.002 eV, which is close to the binding energy of an exciton to a neutral acceptor (0.018 eV). The lifetime of the bound states, determined from the afterglow curves, did not exceed 2×10^{-7} sec. It was concluded that, at temperatures from 30 to 200°K and at current densities from 2.5 to 5.5 A/cm^2, the coherent optical radiation is generated in CdS by transitions representing the annihilation of an exciton bound to a neutral acceptor and the emission of various acoustical phonons. Since the line corresponding to the replica of I_1, accompanied by the emission of a longitudinal optical phonon of 0.038 eV energy, was

fairly strong in CdS at low temperatures, the generation of radiation corresponding to this transition may appear at considerably lower excitation levels than those necessary for the excitation of radiation accompanied by the emission of acoustical phonons. (BBB)

41695 MODIFICATIONS OF RESONANCE FREQUENCY OF DIFFERENT SECTIONS OF QUARTZ PLATES IRRADIATED BY DIFFERENT TYPES OF CORPUSCULAR RADIATION. Felden, Marceau; Comets, Jean-Claude; Haug, Robert (Faculte des Sciences, Nancy). Ann. Telecommun., 22: 284-92(Nov.-Dec. 1967). (In French).

A study of frequency variation of different types of piezoelectric quartz after electromagnetic or corpuscular bombardment is reported. Results were obtained for x rays, electrons, and γ rays; they show that certain sections are insensitive to irradiation, suggesting compensation between parameters determining frequency (e.g., dimensions, density). Other sections are more sensitive; in some cases the result appears to depend very strongly on the angle of the section. A theory is proposed, which is capable of extension to suggested areas, such as the kinetic study of creation and evolution of defects in solids. Sections are classified into two categories, X and Y. The first of these comprises the less sensitive group, usable for study of the natural radiation effects (space telecommunications, relay satellites, etc.). The second is more sensitive and can be used for the study of heavy doses of corpuscular radiation (industrial irradiations, nuclear explosions, nuclear reactor studies). Conceivably a dosimeter may be constructed from the most sensitive sections. (BBB)

41696 THE APPLICATION OF THE MONTE CARLO METHOD TO THE CALCULATION OF THE THERMOCONDUCTIVITY OF DIELECTRICS WITH ISOTOPIC DEFECTS. Ivanov, B. N. (Inst. of High Temperature, Moscow). Teplofiz. Vys. Temp., 6: 447-50(May-June 1968). (In Russian).

A modification of the Monte Carlo method, used for the numerical solution of the linear problems of the microscopic theory of the thermal conductivity of crystalline lattices, is proposed. A scheme for the calculation of the sizes of the peak on the curve of the dependence of the thermal conductivity of the lattice on the temperature is given for an example of pure dielectrics with natural isotopic composition. (tr-auth)

Theoretical Physics

Refer also to abstracts 41320, 41587, 41595, 41832, and 42101.

41697 (BNL-12602) BASIC STATISTICS FOR PHYSICISTS. Martin, B. R. (Brookhaven National Lab., Upton, N. Y.). June 1968. 162p. Dep. CFSTI.

Topics included in the discussion are: (1) probability theory, (2) population parameters, (3) theoretical distributions, (4) sampling, (5) estimation, (6) confidence intervals and regions, and (7) hypothesis testing. (M.O.W.)

41698 NUMERICAL SOLUTION OF QUANTUM-MECHANICAL PAIR EQUATIONS. McKoy, Vincent; Winter, N. W. (California Inst. of Tech., Pasadena). J. Chem. Phys., 48: 5514-23(June 15, 1968).

The numerical solution of the differential equation satisfied by the first-order pair functions of Sinanoglu is discussed and illustrated. An expansion of the pair function in spherical harmonics and the use of finite difference methods convert the differential equation into a set of simultaneous equations. Large systems of such equations can be solved economically. The method is simple and straightforward, and it has been applied to the first-order pair function for helium with $1/r_{12}$ as the perturbation. The results are accurate and encouraging, and since the method is numerical they are indicative of its potential for obtaining atomic-pair functions in general. (auth)

41699 ON THE CONNECTION BETWEEN THE ONE-PARTICLE GREEN'S FUNCTION AND THE DENSITY-DENSITY CORRELATION FUNCTION IN A LARGE BOSE SYSTEM. Kondor, I. Szepfalusy, P. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 24: No. 1, 81-92(1968).

A large system of interacting bosons with a homogeneous condensate at absolute zero temperature is considered. By carrying out an analysis of the perturbation expansion of the one-particle Green's function and the density-density correlation function, a general relationship between them is derived. (auth)

41700 CLASSICAL STATISTICS IN FUNCTIONAL FORMALISM. Quaas, P. (Technische Univ., Dresden); Voss, K.; Ziesche, P. Acta Phys. Acad. Sci. Hung., 24: No. 1, 45-59(1968).

It was shown that by an extension of the Bogolyubov functional, a formalism may be given for treating classical systems in a wide analogy to quantum systems. Essential deviations appear only in the evaluation of expectation values, i.e., in the numerical calculation of physical quantities, because the quantum theoretical trace is replaced by the stem defined here. An essential advantage of functional formalism is its generality. By simple transformations of the used coordinate-momentum states the correlation-momentum representation of Prigogine may be obtained. The formalism may be easily extended to an investigation of elementary excitations and quasi particles in classical systems. Because the difference from the quantum theory is not expressed before calculating the stem, many results of quantum theory, except the evaluation of expectation values, may be taken over from quantum theory. Especially, in the equilibrium theory of classical systems and in the Kubo formalism, analogies to quantum statistics may be well used. But these investigations are postponed to further papers. (auth)

41701 IMPROVED QUANTUM THEORY OF MANY-ELECTRON SYSTEMS. IV. PROPERTIES OF GF WAVEFUNCTIONS. Goddard III, William A. (California Inst. of Tech., Pasadena). J. Chem. Phys., 48: 5337-47(June 15, 1968).

The GF method for obtaining accurate many-electron wavefunctions was described in a previous paper. In this paper, some of the properties of this method are explored, and it is shown that the Hellmann-Feynman, Koopmans', and Brillouin's theorems apply to GF wavefunctions. Calculations are reported on Li_2, CH_4, and CH_3 in order to demonstrate some aspects of the method. (auth)

41702 THE EINSTEIN-PODOLSKY-ROSEN PARADOX: CAN QUANTUM-MECHANICAL DESCRIPTION OF PHYSICAL REALITY BE CONSIDERED COMPLETE? Reisler, Donald Laurence. New Haven, Yale Univ., 1967. 213p.

Thesis.

The original presentation of the EPR paradox required an acceptance of the projection postulate; however, by a slight modification, essentially the same paradox was developed without the use of this postulate. One of the crucial points of the development is the idea of an element of reality. By using the EPR criterion, it was found that a necessary and sufficient condition for a system to contain an element of reality corresponding to some physical quantity is that the system be in an eigenstate of the associated operator. By employing this condition it was deduced that the quantum-mechanical description of physical reality is indeed complete. In the past thirty years, there have been numerous attempts made at resolving the paradox. The major papers were reviewed and their validity in light of the interpretation of quantum mechanics are considered. A general theory of measurement was developed that included the introduction of the concept of an indirect measurement. The notion of a mixed state was carefully examined and several misinterpretations were exposed and clarified. For instance, it was seen that the belief that the mixture's reducible probabilities are a reflection of the observer's ignorance is untenable. By an extension of these ideas about the mixed state, it was seen that the EPR "reality criterion" was contrary to the underlying philosophy of quantum mechanics and their version was modified. A new criterion, based upon results concerning the mixture, led immediately to a resolution of the paradox. However it was also seen that although quantum mechanics is complete according to the EPR definition, it does not offer a description that is analogous to that presented by classical mechanics. It was this feature that Einstein intended to emphasize. The Einstein scientific epistemology was examined and it was found that the results are consistent with its major claims. To demonstrate this, the idea of the general state was introduced and its properties were examined in view of the interpretation of quantum mechanics. Finally, the beliefs and feelings that probably motivated Einstein to propose the paradox were examined and their validity and relevance for quantum theory are commented on. (Diss. Abstr.)

41703 PERTURBATION CORRECTIONS TO THE g TENSOR. Atkins, P. W.; Jamieson, A. M. (Oxford Univ.). Mol. Phys., 14: 425-31(1968).

The Dirac equation for the electron is solved to terms that are second order in the applied field by the application of the Foldy-Wouthuysen transformation. In the process this generates all the terms that are necessary to ensure that the g tensor is gauge-invariant to the third order. An explicit expression is given for the third-order g tensor and the result is compared with the formula given by Tippins (Phys. Rev., 160: 343(1967)). A term that reflects the velocity dependence by the Bohr magneton gives a significant contribution, especially for atoms of high atomic number. This same term is additional to the extra term obtained by Stone (Proc. Roy. Soc., A271: 424(1963)) and is of the same magnitude; it must be invoked to account for the g factor of atomic hydrogen. (auth) (UK)

41704 THE THEORY OF CONDITIONAL INVARIANCE. I. Joseph, A. (Oxford Univ.). Proc. Roy. Soc. (London) Ser. A, 305: 405-27(July 1968).

In order to extend the use of group theoretical arguments to the problem of accidental degeneracy in quantum mechanics a new type of constant of the motion, known as a conditional constant of the motion, is introduced. Such a quantity, instead of commuting with the Hamiltonian H for the system, satisfies the more general relation $HA = A^{\dagger}H$, where $A^{\dagger}$ denotes the hermitian conjugate (adjoint) of the conditional constant of the motion A. This expression reduces, if A is hermitian, to the usual definition of a constant of the motion. Otherwise it defines a new type of invariance, referred to as conditional invariance. A discussion of the difficulties arising from the lack of hermiticity of A, is given. In particular it is shown, under fairly general conditions, that the process of introducing a variable parameter in the Hamiltonian enabling it to have simultaneous eigenfunctions with A, gives rise to an eigenvalue equation in this parameter with respect to which A may be chosen to be hermitian. Conditional invariance is contrasted with both dynamical and geometric invariance. It is found to be sometimes replaceable by either of the latter forms of invariance and, for such, explicit conditions are given. Some applications of conditional invariance are discussed. These include a study of the crossing of potential energy curves, a new model of symmetry breaking, a possible means of calculating the exact number of bound states for certain potentials and conditions for the existence of bound states near the continuum. (auth) (UK)

41705 PATH REPRESENTATIONS OF THE QUANTUM-MECHANICAL ENERGY-LEVEL DENSITY. Bezak, Viktor (Slovak Academy of Sciences, Bratislava). Proc. Cambridge Phil. Soc., 64: 787-93(July 1968).

The quantum-mechanical energy-level density g(E) is given as a functional of the quantum-mechanical kernel $K(q'', q', t''-t')$. On taking the kernel K in the Feynman's form, the function g(E) is obtained without solving a Schrödinger equation. As an example, the embedding of a particle in the one-dimensional square well with infinitely high walls is analysed. The functions $K(x'', x', t''-t')$ and g(E) are represented as sums of terms corresponding to classical paths of different types. By an adequate choice of some terms due to the "most important" paths, partial sums may be constructed giving approximations of the function g(E). The utilization of such approximations for estimation of energy levels is demonstrated. (auth) (UK)

41706 SEARCH FOR A NEW GROUP OF SPACE–TIME TRANSFORMATIONS OF INITIAL AND FINAL STATES. Cook, James Marion. Nashville, Vanderbilt Univ., 1967. 156p.

Thesis.

The purpose of this thesis was to find a new group of mass-changing space–time transformations which may in turn throw new light on the S matrix or the mass spectrum. A set of dynamical variables n_{ij} was studied, which form a Lie algebra when they are simultaneous, i.e., when they pertain to a set of particles that exist at the same time. The Lie algebra of simultaneous n_{ij} was generalized to include certain linear combinations of n_{ij} with momentum-dependent coefficients. It was then found that non-simultaneous n_{ij} (regarded as Heisenberg operators) can constitute a Lie algebra in certain conditions, but it has not been possible to define the conditions completely, or to derive unique structure constants. In an attempt to define transformations that preserve time orders of collisions, two investigations were undertaken. Some conditions were derived that cause generators of transformations to commute with a certain scalar interval between collisions, and some attempts were made to generalize the definition of the space–time vector from one collision of a given particle to the next collision of that particle. (Diss. Abstr.)

41707 TRANSPORT PROPERTIES OF A FERMI LIQUID. Brooker, G. A. (Oxford Univ.); Sykes, J. Phys. Rev. Lett., 21: 279-82(July 29, 1968).

The transport properties of a Fermi liquid were calculated by solving certain integral equations originally derived by Abrikosov and Khalatnikov. Their result for the thermal conductivity is found to be a factor of 2 too large, and the numerical agreement between theory and experiment is improved by applying this correction. The expressions for the viscosity and diffusion coefficients are also reduced from those previously accepted, but by less than 25%. (auth)

41708 WEYL TRANSFORM IN NONRELATIVISTIC QUANTUM DYNAMICS. Leaf, Boris (State Univ. of New York, Cortland). J. Math. Phys. (N. Y.), 9: 769-80(May 1968).

The Weyl transform is applied in quantum dynamics to derive and extend Moyal's statistical theory of phase-space distributions for noncommuting coordinate and momentum operators. The distinction is made between Weyl transforms in Schrödinger and Heisenberg pictures; the general case of time-dependent Hamiltonians is considered. The Wigner function for the probability distribution in a phase space of Cartesian coordinates Q and momenta K propagates according to a conditional probability $P(t,Q,K|t_0,Q_0,K_0)$, which is exhibited as a Feynman path integral in phase space. Properties of $P(t,Q,K|t_0,Q_0,K_0)$ are developed; it is expressed in terms of the quantum generalization of the classical Liouville operator. The Weyl transform of a Heisenberg operator propagates according to $P(t,Q_0,K_0|t_0,Q,K)$ which is also given as Feynman path integral. An equation for the time evolution of Weyl transforms of Heisenberg operators is obtained, according to which the transform of Heisenberg coordinate and momentum operators obey a quantum form of Hamilton's equations of motion. If the initial density operator of the system commutes with the coordinate operator, then the state of the system is a mixture of pure coordinate states; the spectrum of the density operator in this case is continuous. For a Heisenberg operator $A_H(t)$ with Weyl transform $A_H(t,Q,K)$, the function $A(t,Q) = \int dK A_H(t,Q,K)$ is the expectation at time t of the dynamical property for a quantum system initially in a pure state of coordinate Q; it is the quantum-mechanical generalization of the dynamical property of the system along the classical trajectory in configuration space at time t. The probability amplitude for the time dependence of A(t,Q) can be expressed as a Feynman path integral with a Heisenberg Lagrangian. The amplitude of the conditional probability $P(t,Q|t_0,Q_0)$ considered by Feynman is expressed as a path integral with a Schrödinger Lagrangian. The velocity in the Heisenberg Lagrangian is the negative of that in the Schrödinger Lagrangian of Feynman, but it agrees with the velocity appearing in the Hamiltonian equations. It is the Heisenberg Lagrangian that is the Lagrangian of classical dynamics. For a particle whose potential energy is a function of position, a quantum form of Newton's second law is obtained. An extension of the formalism to non-Cartesian coordinate systems is given. (auth)

41709 INTEGRAL REPRESENTATION FOR SYSTEMS OF INTERACTING PARTICLES. Alexanian, Moorad (Univ. of California, Livermore). J. Math. Phys. (N. Y.), 9: 734-7(May 1968).

The ideas in previous work on nonequilibrium systems are extended and include the study of systems of interacting particles in equilibrium. An integral representation is obtained for the distribution function of interacting particles as a superposition of distribution functions for noninteracting particles. In particular, it is shown that an interacting Bose gas need not show Bose condensation and that the behavior near the point E = 0 cannot be more singular than that of a simple pole. (auth)

41710 QUANTUM-MECHANICAL DESCRIPTION OF A BROWNIAN PARTICLE. de la Pena-Auerbach, L. (Univ. de Mexico, Mexico City); Braun, E.; Garcia Colin, L. S. J. Math. Phys. (N. Y.), 9: 668-74(May 1968).

It is shown that the motion of a Brownian particle in the Smoluchowski approximation may be described by a Schrödinger-like equation defining a complex probability amplitude whose norm is the same as the stochastic probability density. Furthermore, the quantum dynamical operators have a physical meaning which arises in a natural way, from the stochastic nature of the process. These operators satisfy the usual commutation relations and thus the uncertainty principle. Here the constant $\hbar$ is replaced by a parameter depending on the characteristics of the system. In particular, the potential-energy operator for a Brownian particle subject to no external forces can be interpreted as a Rayleigh dissipative function. (auth)

41711 EXCITATION PROCESSES IN THE ARGON ION LASER. Mercer, George Nield. New Haven, Yale Univ., 1967. 147p.

Thesis.

An extensive series of investigations of excitation processes for states of the $3p^4 4p$ configuration of singly ionized argon was undertaken. The cross sections for direct electron impact excitation of these levels from the ground state of neutral argon were measured, providing a test of calculations was made using sudden perturbation theory. In addition, collision-induced and radiative relaxation rates and transition probabilities were measured. Gaussian and Lorentzian widths of a number of neutral and ionic transitions were measured in an interferometric study. The ion and neutral drift velocities along the discharge tube axis were measured, as have the radial drift velocities to the discharge tube walls. Excited state densities and discharge characteristics were measured over a wide range of conditions. Using these data the electron density and mean electron energy in the discharge were determined. The fractional importance of the single-step excitation process in a continuously operating argon ion laser was inferred, and estimates of the cross sections necessary to provide the remainder of the observed excitation in various multi-step processes were made. (Diss. Abstr.)

41712 RELATIVISTIC SPACE–TIMES HAVING CORRESPONDING GEODESICS. Williams, G. (Univ. of Denver). J. Phys., A, 1: 457-67(July 1968).

Pairs of relativistic space–times are classified according to their Segrè characteristics. Suitable bases consisting of pseudo-orthonormal tetrads are constructed and the condition that the spaces should have corresponding geodesics is imposed. It is found that the [3,1] and [(3,1)] classes contain spaces with corresponding geodesics. The most general forms of the metrics in these classes are derived. Of these, the vacuum metrics are shown to be algebraically special, in the sense of the Petrov classification. (auth)

41713 MULTI-CONFIGURATION SELF-CONSISTENT FIELD THEORY WITH NON-ORTHOGONAL ORBITALS. Benston, Margaret Lowe (Simon Fraser Univ., Burnaby, British Columbia); Chong, D. P. Mol. Phys., 14: 449-56(1968).

The multi-configuration self-consistent field operator is derived. The orbitals are then transformed into an orthonormal set and pseudoeigenvalue equations are obtained. Possible applications of these equations are discussed. (auth) (UK)

41714 NONRELATIVISTIC APPROXIMATIONS OF THE DIRAC HAMILTONIAN. de Vries, E.; Jonker, J. E. (Univ. of Groningen, Netherlands). Nucl. Phys., B6: 213-25(1968).

It is proved that the nonrelativistic Hamiltonian found by elimination of the small components from the Dirac equation is the same as the Hamiltonian obtained by the Foldy–Wouthuysen transformation. The difficulties with nonhermitian terms are rigorously solved. Moreover, a Hamiltonian was calculated to order $(v/c)^{12}$. The result to order $(v/c)^8$ is also given. (auth)

41715 SOME ASPECTS OF THE QUANTUM THEORY OF MATTER: INDEPENDENT PARTICLE MODELS AND CORRELATION. Smith, Vedene H. Jr. Abstracts of Uppsala Dissertations in Science, No. 90. Uppsala, Uppsala Univ., 1967. 13p. Sw. Crs. 6:-.

Thesis.

The thesis is based on investigations covered by reprint titles published in six different scientific journals. The subject specificity of the investigations is left to be derived from the cited titles which are; Criteria for the Best Independent Particle Model Approximation; Approximation by a Single Slater Determinant; Lower Bounds for the Eigenvalues of First-Order Density Matrices; Open and Closed Shell States in few Particle Quantum Mechanics-Construction of Exact Spin Eigenfunctions; Approximate Natural Orbits for Carbon; Natural Spin Orbits for some Lithium Wavefunctions Containing Explicity Interelectronic Coordinates; Criteria for the Best Bogolyubov Quasi-particle; Cluster Integrals and the Ground State of Bosons with Repulsive Interactions; Theory of Many-Boson Systems: Pair Approximations and the Jastrow Trial Pair Function. (Sweden)

41716 METRICS OF FOUR-DIMENSIONAL SYMMETRICAL LORENTZ SPACES. Cahen, Michel; McLenaghan, Raymond (Univ. Libre, Brussels). Compt. Rend., Ser. A and B, 266: 1125-8(May 27, 1968). (In French).

An exhaustive list is given of the metrics of the four-dimensional symmetrical Lorentz spaces; this construction is made possible by the knowledge of the canonical forms of the Weyl tensor and of the Ricci tensor. (tr-auth)

41717 MICROSCOPIC QUANTUM HYDRODYNAMICS FOR INTERACTING BOSE SYSTEMS. Fanelli, Robert; Struzynski, R. E. (Brooklyn Coll., New York). Phys. Rev., 173: 248-52 (Sept. 5, 1968).

Two equivalent microscopic formulations of quantum hydrodynamics are developed. Commutation rules for hydrodynamical quantities are developed, and in particular, the commutation rule for components of the fluid velocity operator is found to be in disagreement with that derived by Landau. Vortex quantization is found to be a natural consequence of the theory. (auth)

41718 CRITICAL-POINT BEHAVIOR OF A MODEL DESCRIBING A SYSTEM OF INTERACTING FERMIONS. Gartenhaus, S. (Purdue Univ., Lafayette, Ind.); Stranahan, G. Phys. Rev., 173: 260-70(Sept. 5, 1968).

An analysis is given of the critical-point behavior of the two-parameter model which was previously shown to yield results which agree with ^{3}He data for the second virial coefficient and for the coexistence curve. The critical-point exponents of the model are calculated and found to be the same as those for a classical van der Waals gas. With the exception of the exponent characterizing the specific-heat singularity, the results agree reasonably well with published data on ^{3}He. (auth)

41719 A TRY SIMPLEST CASES RESOLUTION OF THE ABRAHAM–MINKOWSKI CONTROVERSY OF ELECTROMAGNETIC MOMENTUM IN MATTER. Shockley, W. (Bell Telephone Labs., Inc., Murray Hill, N. J. Stanford Univ., Calif.). Proc. Nat. Acad. Sci. U. S., 60: 807-13(July 1968).

It is the purpose of this communication to establish two conclusions regarding relativistic aspects of electromagnetic momentum in matter and a third conclusion on research methodology. (W.D.M.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 40365.

41720 (CERN-68-24) THE QUARK HUNTERS' PROGRESS. Massam, T. (European Organization for Nuclear Research, Geneva (Switzerland)). July 8, 1968. 32p. Dep.

Conclusions drawn from published works are given at the end of each group of experiments. The results are summarized as follows: i) experiments on proton machines have not been extended to the highest mass limits kinematically possible from the present machines; ii) for several of the possible quark charge states, statistics are inadequate; iii) in order to have results which are clearly below statistical model predictions, experiments need to be up to 1000 times better; iv) cosmic rays are useful mainly as existence experiments: in production experiments, they do not compare well with either present or proposed accelerators; v) if the experiments on the charge content of matter can be shown to be correct and can be fully understood, then these methods are able to give the best limit on existence. (auth)

Electromagnetic

41721 (DESY-68/31) TOTAL CROSS SECTION FOR PHOTOPRODUCTION OF HADRONS ON PROTONS UP TO 5 GeV. Hilpert, H. G.; Schnackers, H.; Weber, H.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). June 1968. 12p. Dep.

The total hadronic γ-proton cross section was measured for photon energies between 0.5 and 5.0 GeV. For this measurement the primary photon energy of photoproduction events in a hydrogen bubble chamber was determined by a counter arrangement. (auth)

41722 (JINR-P1-3919) INVESTIGATION OF ELECTRON-PHOTON SHOWERS INDUCED BY γ-QUANTA AT 100, 200, 500, AND 2000 MeV IN LIQUID XENON. Slovinskii, B.; Strugal'skii, Z. S.; Yanovskaya, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 19p. (In Russian). Dep.

The electron-photon showers, produced by γ quanta in liquid xenon at E_γ = 100, 200, 500, and 2000 MeV, are being investigated. The experimental data concerning the fluctuations in the development of these showers were obtained. (auth)

41723 (JINR-P14-3832) DEPENDENCE OF NEGATIVE MUON RESIDUAL POLARIZATION IN WATER UPON TEMPERATURE. Evseev, V. S.; Roganov, V. S.; Chernogorova, V. A.; Myasishcheva, G. G.; Obukhov, Yu. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 5p. (In Russian). Dep.

The asymmetry coefficient in the angular distribution of electrons from the μ^- decay was measured in water at various temperatures ranging from –196°C to +100°C by the muon spin precession method. The dependence of the residual muon polarization on the temperature was observed. This fact is entirely not explainable from the point of view of the cascade depolarization theory for isolated mesic atoms. The explanation of the dependence of the residual muon polarization on the t should be searched for, apparently, in the interaction of the produced mesic atom with medium. (auth)

41724 EXPERIMENTAL TEST OF C INVARIANCE IN $\eta \rightarrow \pi^+\pi^-\pi^0$. Gormley, M.; Hyman, E.; Lee, W.; Nash, T.; Peoples, J.; Schultz, C.; Stein, S. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 21: 402-6(Aug. 5, 1968).

An asymmetry of 1.5 ± 0.5% based on 36,800 events of $\eta \rightarrow \pi^+\pi^-\pi^0$ is reported. (auth)

41725 EXPERIMENTAL TEST OF C INVARIANCE IN $\eta \rightarrow \pi^+\pi^-\gamma$. Gormley, M.; Hyman, E.; Lee, W.; Nash, T.; Peoples, J.; Schultz, C.; Stein, S. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 21: 399-402(Aug. 5, 1968).

An asymmetry of 2.4 ± 1.4% based on 6710 events of $\eta \rightarrow \pi^+\pi^-\gamma$ is reported. (auth)

41726 MEASUREMENTS OF π^0 AND η^0 PHOTOPRODUCTION AT INCIDENT GAMMA-RAY ENERGIES OF 6.0 TO 17.8 GeV. Anderson, R. (Stanford Linear Accelerator Center, Calif.); Gustavson, D.; Johnson, J.; Ritson, D.; Jones, W. G.; Kreinick, D.; Murphy, F.; Weinstein, R. Phys. Rev. Lett., 21: 384-6 (Aug. 5, 1968).

Cross-section measurements on the photoproduction of π^0 η^0 mesons on hydrogen are reported for a range in t of –0.2 to –0.9 $(GeV/c)^2$ and for a range of energies 6.0 to 16.0 GeV. The sharp dip observed at lower energies at t = –0.5 for π^0 production becomes less pronounced at higher energies. This implies in the Regge framework the B^0 meson trajectory dominates at higher energies. Our one angular distribution for η^0 production at 6.0 GeV shows no dip at t = –0.5 as do the π^0 data. (auth)

Weak

Refer also to abstract 41764.

41727 ANALYSING POWER OF EMULSIONS ON POLARIZED PROTONS EMITTED IN THE DECAY $\Sigma^+ \rightarrow p + \pi^0$. Mora, S. (Univ., Parma, Italy). Nuovo Cim., 56A: 790-2(Aug. 1, 1968).

Measurements were made of the analyzing power on Ilford K-5 nuclear emulsions, exposed to K^--mesons; events of the type $K^- + p \rightarrow \Sigma^+ + \pi^-$ produced on complex nuclei were considered. Events were selected for which the Σ^+ decays in flight following the $\Sigma^+ \rightarrow p + \pi^0$ reaction and for proton scattering angles $\theta > 5°$. The analyzing power P was found to be 0.30 ± 0.20. It is concluded that this low value makes it difficult to observe in nuclear emulsions polarization effects on polarized protons in 10 to 50 MeV range. (L.B.S.)

Strong (Baryon-Induced)

Refer also to abstracts 40366, 41746, and 41944.

41728 (BNL-12673) AN INVESTIGATION OF LOW-MULTIPLICITY FINAL STATES IN pp INTERACTIONS AT 28.5 GeV/c. Ellis, W. E.; Miller, D. J.; Morris, T. W.; Panvini, R. S.; Thorndike, A. M. (Brookhaven National Lab., Upton, N. Y.); Berger, E. L. (Dartmouth Coll., Hanover, N. H.). [1968]. 60p. (CONF-680809-10). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Results are presented from a 28.5-GeV/c p + p bubble chamber experiment for the study of single isobar production. The three-body $pn\pi^+$ and Δ^{++} (1236)$p\pi^-$ final states observed in the data are fitted by a double Regge pole exchange model calculation. The 1400 MeV enhancement, and fits to several kinematical variables, for the $pn\pi^+$ and Δ^{++} final states, obtained from the double Regge calculation are discussed. (J.F.P.)

41729 (BNL-12674) COHERENT PRODUCTION OF THE $p\pi^+\pi^-$ ENHANCEMENT AT 1470 MeV BY 28-GeV/c PROTONS ON NEON. Huson, F. R.; Miller, D. J.; O'Neall, J. S. (Brookhaven National Lab., Upton, N. Y.). [1968]. 19p. (CONF-680809-11). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

In a 28-GeV/c proton exposure of a neon-hydrogen bubble chamber, coherent production of $p\pi^+\pi^-$ was observed. The "1470" enhancement seen in pp experiments dominates the coherent channel. A comparison of its cross section on neon with pp results at 28.5 GeV, using a nuclear absorption model, shows that the total cross section for the $p\pi^+\pi^-$ final state on nucleons is greater than 70 mb, which makes it unlikely that the 1470 is a resonance. Its production and decay angular distributions indicate appreciable parity mixing. (auth)

Strong (Meson-Induced)

41730 (BNL-12611) EXPERIMENTAL REVIEW OF MESON RESONANCES DECAYING INTO ($K\bar{K}$) STATES. Lai, Kwan Wu (Brookhaven National Lab., Upton, N. Y.). [1968]. 32p. (CONF-680428-7). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

The isosinglet and isotriplet mesons having the $K\bar{K}$ decay mode are reviewed. The mesons are chosen which either are less well established or have significant recent developments. The production reactions and decays of these mesons are briefly summarized. (J.F.P.)

41731 (BNL-12676) ENHANCEMENTS IN THE 2 AND 3 PION MASS SPECTRA NEAR 1.7 GeV OBSERVED IN THE REACTION OF 8 GeV/C π^+ MESONS WITH DEUTERIUM. Cnops, A. M.; Hough, P. V. C.; Huson, F. R.; (and others) (Brookhaven National Lab., Upton, N. Y.). [1968]. 8p. (CONF-680809-9). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Neutral, even g-parity systems and both charged and neutral odd g-parity systems were observed. In particular the charged and neutral 3π systems are compared. The deuterium bubble chamber was exposed to a beam of 8-GeV/c π^+. The channels $\pi^+ + d \rightarrow 2p + \pi^+ + \pi^-$, $\pi^+ + d \rightarrow \pi^+ + \pi^- + \pi^0 + 2p$, $\pi^+ + d \rightarrow 2p + 2\pi^+ + 2\pi^-$, and $\pi^+ + d \rightarrow n + p + 2\pi^+ + \pi^-$ are studied. Three enhancements were observed. These were an even g-parity neutral enhancement of mass 1707 ± 16 decaying into two pions, and odd g-parity neutral enhancement of mass 1667 ± 16 MeV decaying predominantly into $\rho\pi$ and with $\rho\pi$ branching ratios consistent with an I = 0 assignment, and an odd g-parity charged enhancement of mass 1710 ± 22 MeV for which no evidence is found for either strong $\rho^0\pi^+$ or $f^0\pi^+$ decay modes. From the differences in decay modes it is concluded that the two odd g-parity enhancements are different states. (J.F.P.)

41732 (BNL-12677) COHERENT PRODUCTION OF $\pi^+\pi^+\pi^-$ IN DEUTERIUM BY 8 GeV/c π^+. Cnops, A. M.; Hough, P. V. C.; Huson, F. R.; (and others) (Brookhaven National Lab., Upton, N. Y.). [1968]. 16p. (CONF-680809-8). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

There were 45,000 events measured from the exposure of a deuterium bubble chamber to a beam of 8-GeV/c mesons (π^+). The channels studied were $\pi^+ + d \rightarrow 2\pi^+ + \pi^- + d$, $\pi^+ + d \rightarrow 2\pi^+ + \pi^- + n + p$, and $\pi^+ + d \rightarrow \pi^+ + \pi^- + \pi^0 + 2p$. In the coherent events a diffractively produced πp peak was observed which has characteristics compatible with the low-mass πp system produced in pion–nucleon interactions and which has a J^{PG} of 1^+. The mass distribution fits a Breit–Wigner distribution with a mass of 1.16 GeV and a width of 0.34 ± 0.025 GeV. The peak is interpreted as due to a Deck type mechanism. (J.F.P.)

41733 (COO-1428-70) MESON STATES IN π^+d REACTIONS AT 2.7 GeV/c. Avison, D.; Campbell, J.; Ezell, C.; Garfinkel, A. F.; Gezelter, J.; Lichtman, S.; Loeffler, F.; Miller, R.; Willmann, R. (Purdue Univ., Lafayette, Ind.). July 1968. Contract AT(11-1)-1428. 26p. (CONF-680809-1). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

A preliminary report is given on the production of meson resonances in $\pi^+ + d$ reactions at 2.7 GeV/c. The data were obtained from the analysis of 100,000 pictures of a D_2 chamber. The reactions studied are $\pi^+ + d \rightarrow 2p + \pi^+ + \pi^- + \pi^0$ (for which the analysis is nearly complete), $\pi^+ + d \rightarrow 2p + \pi^+ + \pi^- + (MM \geq 2\pi^0)$, $\pi^+ + d \rightarrow 2\pi^+ + 2\pi^- + \pi^0$, and $\pi^+ + d \rightarrow 2p + K^+ + K^-$. The meson resonances η^0, ω^0, H, A_1, and A_2 are studied in the first reaction. The $\eta(960)$ is studied in the second and third reactions, and the $\Lambda(1520)$ is studied in the last reaction. (J.F.P.)

41734 (COO-1428-71) TWO-PRONG INTERACTIONS IN π^-p AT 2.7, 4.2, AND 5.0 GeV/c. Carmony, D.; Eisner, R.; Gutay, L.; (and others) (Purdue Univ., Lafayette, Ind.). July 1968. Contract AT(11-1)-1428. 17p. (CONF-680809-3). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Results from a study of two-prong final states from a 150,000 picture π^- + p run at 5.0 GeV/c in a bubble chamber are presented. Production cross sections and meson resonance cross sections for the two-prong final states are given, and histograms of the $\pi\pi$ effective mass for the reactions $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ and $\pi^- + \pi^+ + n$, respectively. The structure of the f^0, the A_2 splitting, and various N^* resonances are studied. Also the A_2 and $A_{1.5}$ resonances are found in the reaction $\pi^- + p \rightarrow \pi^- + p + MM$, where MM is the mass of unobserved neutral particles. (J.F.P.)

41735 (COO-1428-72) STRANGE PARTICLES IN π^-p INTERACTIONS AT 5.0 GeV/c. Weisbach, P. J.; Howard, C. G.; Palfrey, T. R.; Sahni, R. J. (Purdue Univ., Lafayette, Ind.). July 1968. Contract AT(11-1)-1428. 25p. (CONF-680809-6). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

The analysis of strange particle events obtained from a 150,000 picture exposure to a 5.0 GeV/c π^- beam in a hydrogen bubble chamber is reported. YK enhancements are seen in both the $\Lambda K^+\pi^-$ and $\Sigma^-K^+\pi^0$ final states. The ΛK^+ enhancement, generally attributed to the N(1688) is consistent with previous data. But the Σ^-K^+ enhancement favors the production of a low angular momentum resonance which decays into ΣK. Two $\Sigma K\pi$ peaks are observed in the five-body final states at masses of 2.19 and 2.42 GeV. The possible interpretation of these peaks as production of the N(2190) and $\Delta(2420)$ was suggested. (J.F.P.)

41736 (COO-1428-81) POLARIZATION OF THE Λ HYPERON FOR THE REACTION $K^-n \rightarrow \pi^-\Lambda$ AT 4.5 GeV/c. Yen, W. L.; Ammann, A. C.; Carmony, D. D.; Eisner, R. L.; Garfinkel, A. F.; Gutay, L. J.; Miller, D. H.; Tautfest, G. W. (Purdue Univ., Lafayette, Ind. Dept. of Physics). July 1968. Contract AT(11-1)-1428. 6p. (CONF-680809-7). Dep. CFSTI.

From International Conference on High Energy Physics, Vienna, Austria.

A preliminary study of the Λ polarization in the reaction $K^- + n \rightarrow \pi^- + \Lambda$ is presented, and the result is compared with a recent double Regge pole prediction. A deuterium bubble chamber was exposed to a 4.5 GeV/c K^- beam. The partial cross section, momentum transfer distribution, as well as the polarization of the hyperon (Λ) were determined. (J.F.P.)

41737 (COO-1428-82) THE REACTION $K^-d \rightarrow K^{*-}(890)d$ AT 4.5 GeV/c. Eisner, R. L.; Ammann, A. C.; Carmony, D. D.; Garfinkel, A. F.; Gutay, L. J.; Miller, D. H.; Tautfest, G. W.; Yen, W. L. (Purdue Univ., Lafayette, Ind.). July 1968. Contract AT(11-1)-1428. 10p. (CONF-680809-4). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

The ω-exchange contribution to $K^{*-}(890)$ production off deuterium at an incident K^- momentum of 4.5 GeV/c is discussed. The reaction $K^- + d \rightarrow \bar{K}^0 + \pi^- + d$ is studied in 68 events found in a deuterium bubble chamber. The $\bar{K}^0\pi^-$ effective mass spectrum is shown. (J.F.P.)

41738 (COO-1428-83) THE REACTION $\pi^+d \rightarrow d\pi^+\pi^+\pi^-$ AT 2.7 GeV/c. Avison, D.; Campbell, J.; Ezell, C.; Gezelter, J.; Lichtman, S.; Loeffler, F.; Miller, R.; Willman, R. (Purdue Univ., Lafayette, Ind.). July 1968. Contract AT(11-1)-1428. 19p. (CONF-680809-2). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Properties of the reaction $\pi^+d \rightarrow d\pi^+\pi^+\pi^-$ at 2.7 GeV/c are reported. The cross section is 150 μb. There is no significant evidence for production of mesons which decay to $\pi^+\pi^+\pi^-$. The $d\pi$ and $\pi\pi$ mass spectra are discussed. The d^{*++} and ρ^0 are strongly produced. It is shown that d^{*0}, which seems as copiously produced as d^{*++}, cannot be fully accounted for by reflections of the d^{*++} or the ρ^0. The relevance of the one pion exchange model is discussed. (auth)

41739 (COO-1428-84) OBSERVATION OF AN I = 0 $\pi^-\pi^+$ RESONANCE AT A MASS OF 1.05 GeV. Miller, D. H.; Gutay, L. J. (Purdue Univ., Lafayette, Ind.); Johnson, P. B.; Kenney, P. (Notre Dame Univ., Ind.); Guiragussion, Z. (Stanford Linear Accelerator Center, Calif.). July 1968. Contract AT(11-1)-1428. 9p. (CONF-680809-5). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

An I = 0 enhancement at 1.050 ± 0.01 GeV was observed in the $\pi^-\pi^+$ final state in 7916 events belonging to the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ at an average incident beam momentum of 4.0 GeV/c. This enhancement is produced primarily at a four momentum transfer of less than 0.1 GeV^2 and observed most clearly in the region $\cos\theta < -0.75$, where θ is the angle between the outgoing and incident π^- in the dipion rest system. The decay angular distribution is best fitted by a D wave, and this enhancement appears to be incompatible with the S^* previously observed in the $K\bar{K}$ final state. (J.F.P.)

41740 (COO-1749-2 and Add.) HIGH MOMENTUM TRANSFER STUDIES OF $\pi^-p \rightarrow \pi^0n$ TO BE PERFORMED AT THE ZERO GRADIENT SYNCHROTRON, ARGONNE NATIONAL LABORATORY. (Case-Western Reserve Univ., Cleveland, Ohio). May 8, 1968. Contract AT(11-1)-1749. 21p. Dep. CFSTI.

Experiments are proposed for the study of the reactions $\pi^- + p \rightarrow \pi^0 + n$ and $\pi^- + p \rightarrow \eta^0 + n$ at 3.0 to 6.0 GeV/c at a t of 1.5 to 6.0 (GeV/c)^2. The experimental arrangement using spark chambers, the expected event rate, and the background arising from $\pi^- + p \rightarrow \pi^0 + \pi^0 + n$ are discussed. Also the compatibility of studying the reactions $K^- + p \rightarrow \bar{K}^0 + n$ and $\pi^- + p \rightarrow \Lambda^0(\Sigma^0) + K^0$ is considered to determine whether useful information can be obtained during the same run without jeopardizing the main measurement. (J.F.P.)

41741 (COO-1749-5) A RESEARCH PROGRAM IN HIGH-ENERGY ACCELERATOR PHYSICS AND LOW-LEVEL COUNTING ELEMENTARY PARTICLE PHYSICS. Technical Report, October 1, 1967–September 1968. Jenkins, T. L. (Case-Western Reserve Univ., Cleveland, Ohio). June 1968. Contract AT(11-1)-1749. 12p. Dep. CFSTI.

Research on high-energy physics experiments is briefly discussed including the neutrino and low-level counting work, a search for double beta decay in ^{150}Nd, and an experiment to set a limit on the lifetime of the proton. Preparations are made for a series of experiments studying the charge exchange reaction $\pi^- + p \rightarrow \pi^0 + n$ at various energies, and analysis is started on the inelastic scattering of 12-GeV mucns from carbon and hydrogen, and the search for a CP violating contribution in the decay mode $K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0$. For the last experiment preliminary results are given. (J.F.P.)

41742 (JINR-P1-3862) COMPARISON OF THE LIFE-TIMES OF THE CHARGED PIONS. Petrukhin, V. I.; Rykalin, V. I.; Khazins, D. M.; Tsisek, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 22p. (In Russian). Dep.

The lifetimes of the charged pions are compared in order to check the CPT-theorem. The experiment is based on the comparison of the attenuation of π^+- and π^--meson beams (having the momentum p = 180 MeV/c) which is due to their decay in flight. The maximum change of the path length is equal to 6.84m, which corresponds to 0.683 of the π-meson decay length with the above momentum. The identification of the π-mesons and the measurement of their velocities were performed with the aid of a time-of-flight spectrometer having a time resolution of $2\tau = 0.65$ nsec. The value of the difference of the charged pion lifetimes is found to be $\tau_+/\tau_- - 1 = (-0.14 \pm 0.29)\%$. (auth)

41743 (UCRL-18316) K* SPECTRUM AND DIFFRACTION DISSOCIATION EFFECTS (INCLUDING A_1). Goldhaber, Gerson (California Univ., Berkeley. Lawrence Radiation Lab.). June 1968. Contract W-7405-eng-48. 40p. (CONF-680428-6). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

A review is given for the K* spectrum and diffraction dissociation effects. A survey of the K*'s, including reactions leading to K* production, the Q peak and K*(1420), structure in the Q peak, spin and parity of the Q peak, and comparison with the quark model are covered. Also the next K* cluster, evidence for an enhancement in the ΛN mass distribution, and the A_1 and the general A enhancement including A_1 production outside a diffraction dissociation peak, and resonance versus the Deck effect are discussed. (J.F.P.)

41744 STRUCTURE IN BACKWARD PION-PROTON ELASTIC SCATTERING FROM 6 TO 17 GeV/c. Orear, J. (Cornell Univ., Ithaca, N. Y.); Owen, D. P.; Peterson, F. C.; Read, A. L.; Ryan, D. G.; White, D. H.; Ashmore, A.; Damerell, C. J. S.; Frisken, W. R.; Rubinstein, R. Phys. Rev. Lett., 21: 389-92(Aug. 5, 1968).

The angular distribution for elastic π^+-p scattering was measured over the angular range $135° < \theta_{cm} < 180°$ for pion laboratory momenta of 5.9, 9.9, and 13.7 GeV/c and also for π^-p at 5.9 and 9.9 GeV/c. More limited angular distributions are presented for π^--p at 13.7 and 16.3 GeV/c and π^+-p at 17.1 GeV/c. In both the π^--p and π^+-p scattering the cross section rises by over 2 orders of magnitude in the backward direction; for π^+-p only, there is a sharp dip at $u = -0.15$ (GeV/c)^2. (auth)

41745 $K_1^0K_1^0$ THRESHOLD ENHANCEMENT IN $\pi^-p \rightarrow K_1^0K_1^0n$ AT 4 AND 5 GeV/c. Hoang, T. F. (Argonne National Lab., Ill.); Eartly, D. P.; Pnelan, J. J.; (and others). Phys. Rev. Lett., 21: 316-19(July 29, 1968).

The reaction $\pi^-p \rightarrow K_1^0K_1^0n$ was investigated at 4 and 5 GeV/c in a spark-chamber experiment. The threshold enhancement in the s-wave $K_1^0K_1^0$ system can be fitted by either a complex scattering length or by a resonance form. (auth)

41746 HIGH-ENERGY π^--p, K^--p, AND $\bar{p}$-p ELASTIC SCATTERING. Ashmore, A. (Brookhaven National Lab., Upton, N. Y.) Damerell, C. J. S.; Frisken, W. R.; Rubinstein, R.; Orear, J.; Owen, D. P.; Peterson, F. C.; Read, A. L.; Ryan, D. G.; White, D. H. Phys. Rev. Lett., 21: 387-9(Aug. 5, 1968).

Differential cross sections for elastic scattering of 6-GeV/c π^-, K^-, and $\bar{p}$ from protons were measured in the angular range 25° to 105° (cm system) and for 8-GeV/c π^- in the angular range 75° to 115° (cm system). Structure in the angular distributions was observed. (auth)

41747 A NEW DETERMINATION OF THE CAPTURE RATIO $r_c = (\Sigma^-p \rightarrow \Sigma^0n)/[(\Sigma^-p \rightarrow \Sigma^0n) + (\Sigma^-p \rightarrow \Lambda^0n)]$, THE Λ^0-LIFE-TIME, AND THE $\Sigma^- - \Lambda^0$ MASS DIFFERENCE. Hepp, V.; Schleich, H. (Univ., Heidelberg). Z. Phys., 214: 71-7(1968).

The two Σ^- reactions at rest $\Sigma^-p \rightarrow \Sigma^0n$ and $\Sigma^-p \rightarrow \Lambda^0n$ were studied in order to determine the capture ratio $r_c = (\Sigma^-p \rightarrow \Sigma^0n)/[(\Sigma^-p \rightarrow \Sigma^0n) + (\Sigma^-p \rightarrow \Lambda^0n)]$, the Λ^0-lifetime and the $\Sigma^- - \Lambda^0$ mass difference. The following results were obtained: $r_c = 0.474 \pm 0.016$; $\tau_{\Lambda^0} = (2.47 \pm 0.08) \times 10^{-10}$ sec; and $M_{\Sigma^-} - M_{\Lambda^0} = 81.64 \pm 0.09$ MeV/c^2. The Σ^--mass was determined from the range of the stopping Σ^--hyperons, $M_{\Sigma^-} = 1197.19 \pm 0.32$ MeV/c^2. (auth)

41748 ELASTIC SCATTERING OF NEGATIVE KAONS ON POLARIZED PROTONS BETWEEN 1.4 AND 2.4 GeV/c. Daum, C.; Erne, F. C.; Lagnaux, J. P.; Sens, J. C.; Steuer, M.; Udo, F. (CERN, Geneva). Nucl. Phys., B6: 273-324(1968).

The elastic scattering of negative kaons on polarized protons was investigated in the range of kaon momenta 1.4 to 2.4 GeV/c. Measurements of intensity and polarization angular distributions are presented for 19 incident momenta in this range. The results are parametrized in Legendre expansion coefficients. The possibility of extracting resonance parameters from the data is discussed. A common feature of the distributions is the occurrence of two dips in the differential cross sections, accompanied by zero crossings in the polarizations. The first dip and zero crossing is at $-t = 0.78$ (GeV/c)^2, independent of incident momentum: the second dip and zero crossing is at $-u \approx 0.3$ (GeV/c)^2, also independent of incident momentum. (auth)

41749 π^+n INTERACTIONS AT 3.29 GeV/c: FOUR- AND FIVE-PION EVENTS. Bugg, W. M. (Univ. of Tenn., Knoxville. Oak Ridge National Lab., Tenn.); Condo, G. T.; Humphreys, J. T.; McCulloch, R. D.; Cohn, H. O. Nucl. Phys., B6: 246-54(1968).

The four- and five-pion systems from $\pi^+ + n$ reactions at 3.29 GeV/c are studied. In the 4π system strong resonant production is confined to the $N^{*2+}(1238)$ and ρ^0 meson, while weaker production of $N^{*0}(1238)$ is also observed. The interaction is suggestive of exchange mechanisms other than single charged meson exchange. No evidence is found for the isobars to be the decay products of higher resonances. The ρ^0 produced in association with N^{*2+} does not exhibit the usual large forward-backward asymmetry. For the five pion final state strong ω^0 production is observed. (auth)

41750 SOME ASPECTS OF Λ^0 PRODUCTION IN MULTIBODY FINAL STATES PRODUCED IN 6 GeV/c K^-p INTERACTIONS. Sisterson, L. K. (London Univ.); Paler, K.; Miller, D. D.; (and others). Nucl. Phys., B6: 205-12(1968).

The center-of-mass angular distributions of the Λ^0 produced in final states with three, four, five and six particles are compared with those of other baryons in final states with the same multiplicity. A forward Λ^0 peak, consistent with a baryon-exchange mechanism contribution, is found in all Λ^0 final states studied. The polarization of the Λ^0 as a function of the Λ^0 production angle is studied for each final state. (auth)

41751 SOME FEATURES OF NEUTRAL PION PRODUCTION IN INTERACTIONS OF 9 GeV NEGATIVE PIONS WITH XENON NUCLEI. Siemiarczuk, T. (Univ. of Warsaw). Acta Phys. Pol., 33: 879-85(June 1968).

The energy and angle of emission of 3271 photons emitted in 1374 π^--Xe interactions at 9 GeV were measured and the process leading to π^0 production is discussed. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 41867 and 42144.

41752 (COO-1428-64) ANNUAL PROGRESS REPORT [ON HIGH ENERGY PHYSICS], JUNE 1, 1967-MAY 31, 1968. [Sugawara, Masao] (Purdue Univ., Lafayette, Ind.). Contract AT-(11-1)-1428. 27p. Dep. CFSTI.

Theoretical research on high-energy physics at Purdue University is summarized. This research includes interactions, resonance production, symmetry groups, decays, coupling constants, dispersion relations, the quark model, and Regge pole theory. (J.F.P.)

41753 (JINR-P2-3896) BEHAVIOR OF THE DIFFRACTION PEAK FOR PARTICLES WITH ARBITRARY SPINS. Nguyen thi Hong (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 16p. (In Russian). Dep.

It is shown that the lower bound for the width of the diffraction peak at $s \rightarrow \infty$ $\Delta \gtrsim (\text{const}/\ln^2 s)$, obtained by Logunov et al. for spinless particles holds also for particles with arbitrary spins. (auth)

41754 (JINR-P2-3897) SHRINKAGE OF THE FORWARD AND BACKWARD DIFFRACTION PEAKS. Nguyen Van Hieu; Nguyen Ngoc Thuan; Suleimanov, V. A. (Joint Inst. for Nuclear Research,

Dubna (USSR). Lab. of Theoretical Physics). 1968. 20p. (In Russian). Dep.

Various upper bounds for the ratios of the differential to the total cross sections of the elastic and inelastic processes are established. It was shown also that Orear's empirical formula contradicts the Mandelstam representation. (auth)

41755 (JINR-P2-3902) LECTURES ON RELATIVISTIC KINEMATICS. Muradyan, R. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 28p. (In Russian). Dep.

The principal theses of the relativistic kinematics are considered. (25 references) (auth)

41756 DE SITTER MODEL FOR STABLE PARTICLES. Burcev, P. (Univ., Brno). Nuovo Cim., 56A: 795-8(Aug. 1, 1968).

A structural model for stable particles is presented in which the particle is identified with the source of the static spherically-symmetric closed de Sitter manifold and is characterized by two invariant parameters, mass M and radius R. The values of M and R for which the model exists are determined. (L.B.S.)

41757 CHARACTERIZATION OF UNSTABLE PARTICLES. Sirugue-Collin, M. (Faculte des Sciences, Marseille). Nuovo Cim., 56A: 567-81(Aug. 1, 1968).

Using a model of π, N, $\bar{N}$ interaction, a study is made of the Heisenberg operators, expressed in term of physical operators. The introduction of a renormalization constant ζ for the meson leads to the characterization of an unstable particle by the condition $\zeta = 0$. Recalling the characterization of stable and unstable particles by means of poles in scattering amplitude, it is shown that the $\zeta = 0$ condition implies the disappearance of the real pole for the meson and consequently of the corresponding stable particle. (auth)

41758 MASSES OF ELEMENTARY PARTICLES AND THE MULTITEMPORAL THEORY OF RELATIVITY. Kalitsin, Nikola St. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 117-31(1968).

A multitemporal theory of relativity previously proposed is discussed for the masses of elementary particles. According to this theory the physical world possesses three spacelike and infinitely many timelike coordinates. In this theory two fundamental properties of elementary particles, mass and lifetime, are connected. A table listing the masses of the stable particles is given, and also the masses of the resonances are calculated. (J.F.P.)

41759 IMPROVED METHOD FOR QUANTUM-MECHANICAL THREE-BODY PROBLEM. III. USE OF STURMIAN FUNCTIONS. Eyges, Leonard; Jasperse, John R. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Math. Phys. (N. Y.), 9: 805-12(May 1968).

Previous work on the ground state of the symmetric three-body problem is extended by expanding the two-body orbitals $\varphi(k,\kappa)$ or $\varphi(k,\varkappa)$ (one and three dimensions, respectively) in a set of Sturmian functions. This retains the advantages of the previous expansions, and gains several new ones as well. Among these are a simplification of the equations and a transparent way of estimating convergence. The one-dimensional problem is reduced to an infinite set of coupled integral equations in one variable and the three-dimensional one to a doubly infinite set. As an application and a test of convergence the one-dimensional equations were solved numerically in successive truncations. It is found that keeping only the first term of the set yields results typically accurate to a fraction of a percent. (auth)

41760 ADMISSIBLE MASS DISTRIBUTIONS OF UNSTABLE PARTICLES. Khalfin, L. A. (Inst. of Mathematics, Leningrad). JETP Lett. (USSR) (Engl. Transl.) 7: 267-9(May 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 341-5(May 5, 1968).

The necessary and sufficient conditions for the admissibility of mass distributions of unstable particles are presented in a general formulation. (L.B.S.)

41761 NOTE ON THE MASS FORMULA $m = nm_0$. Dowker, J. S. (Univ. of Manchester, Eng.). J. Phys., A, 1: 455-6(July 1968).

The existence of a gravitational dual-mass particle is postulated to account for the mass quantization rule $m = nm_0$ in the same way that Dirac's magnetic monopole accounts for the quantization of charge. Some properties of "dual matter" are mentioned. (auth)

41762 THREE SPECTROSCOPIES. Weisskopf, Victor F. Sci. Amer., 218: No. 5, 15-29(May 1968).

The structure and properties of elementary particles produced in large accelerators are treated in a manner analogous to atomic and nuclear spectra. The baryon and meson spectra are discussed in detail. The quark model of baryons and mesons, which has been successful in describing the properties of quantum states and the transitions between them, is also discussed. (L.B.S.)

41763 ELEMENTARY PARTICLES, 1968. PART I. Kunszt, Zoltan (Lorant Eoetvoes Univ., Budapest). Fiz. Szemle, 18: 209-15(July 1968). (In Hungarian).

As a result of increased research in the field of subatomic particles, the number of known elementary particles keeps increasing, although all of them are not considered elementary in the same sense as the proton and the neutron. Of the four types of interaction—gravitational, weak, electromagnetic, and strong—the first one is not involved at all in elementary particle processes; the strong interactions are the most important ones in this respect. The ultimate goal of the current studies is to develop a theory to satisfy the experimentally observed properties of strong-interaction-induced processes. This is a difficult problem; the spectra of the thus far discovered resonances revealed that the interaction is quite complicated. The problems reviewed are: characteristic quantum numbers of hadron states, unitary multiplets, research on resonances, experimental determination of quantum numbers, formation and production experiments, the missing-mass method, and bubble-chamber measurements. In the examination of baryon and meson resonances, plotting of Dalitz diagrams was found to be very useful to determine the mass or spin-parity of resonances. (Review article). (TTT)

41764 PROCEEDINGS OF THE SECOND HAWAII TOPICAL CONFERENCE IN PARTICLE PHYSICS, UNIVERSITY OF HAWAII, HONOLULU, AUGUST 14-25, 1967. Pakvasa, S.; Tuan, S. F. (eds.). Honolulu, Hawaii, University of Hawaii Press, 1968. 466p. $6.75. (CONF-670841).

The conference included five papers. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 41765, 41801, 41802, 41833, and 41836.

41765 ALGEBRA OF THE OBSERVED CURRENT OPERATORS. Lee, T. D. (Columbia Univ., New York). pp 11-63 of Proceedings of the Second Hawaii Topical Conference in Particle Physics, University of Hawaii, Honolulu. Pakvasa, S.; Tuan, S. F. (eds.). Honolulu, Hawaii, University of Hawaii Press, 1968.

See CONF-670841.

The discussion of the algebra of observed current operators covers a review of current algebra, field-current identity, the application to $\langle J_\mu^I \rangle I = 1$, the isoscalar electromagnetic current, and the algebra of observed currents. (J.F.P.)

Electromagnetic

Refer also to abstracts 41799, 41806, 41823, 41841, and 41865.

41766 (ANL-Trans-643) ELECTROMAGNETIC RENORMALIZATION OF THE VECTOR PART OF THE $\nu_e e^-$ INTERACTION. Folomeshkin, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report IFVE-STF-67-60-K. 7p. Dep. CFSTI.

The electromagnetic renormalization of the vector part of the $(\nu_e e)$ $(\nu_e e)$-interaction is considered in the first order weak interaction and account is taken of all the orders of electromagnetic interaction. It is shown that this renormalization is finite. The numeral value of the renormalization constant Z^W depends on the total hadron contribution to the vacuum polarization. In any case it holds for the inequalities $\frac{1}{2} \leq Z^W \leq 1$. (auth)

41767 (DESY-68/23) ANALYSIS OF THE PHOTOPRODUCTION OF ω MESONS. Schilling, K.; Storim, F. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). June 1968. 30p. Dep.

We analyse the recent bubble chamber data from the Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration on the process $\gamma p \to p\omega$, assuming that ω photoproduction goes both via diffraction and via elementary pion exchange, where the latter is modified by final state absorption and by the intermediate $\rho^0 p$ state. Bearing in mind the simple assumptions made on the spin structure of the diffraction amplitudes, reasonable agreement of this model with the data is found. (auth)

41768 (DESY-68/28) APPLICATION OF THE OPTICAL THEOREM FOR QUASI-ELASTIC SCATTERING TO THE PHOTOPRODUCTION OF VECTOR MESONS. Knies, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1968. 7p. Dep.

Some consequences of the unitarity of the S-matrix to inelastic diffraction scattering processes are investigated. The application to the photoproduction of vector mesons leads to model independent lower limits on the total cross section for the production of hadrons by photons. (auth)

41769 (DESY-68/33) VECTOR MESON DOMINANCE MODEL AND π^+ PRODUCTION BY UNPOLARIZED AND LINEARLY POLARIZED PHOTONS. Krammer, Margarete; Schildknecht, Dieter (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). June 1968. 35p. Dep.

Using the vector meson dominance model, it is shown that the polarization of vector mesons produced in meson nucleon collisions yields information on pion production by linearly polarized photons. Combining vector dominance and a quark model relation the cross section for charged pion production by linearly polarized photons is predicted. Moreover, the unpolarized $\pi^\pm$ cross sections calculated from the vector dominance and quark models are compared with recent experiments. (auth)

41770 (JINR-P2-3851) LOW THEOREM FOR THE OBSERVABLES. Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 13p. (In Russian). Dep.

The components of any polarization tensor of any process, which is accompanied by the soft photon emission, are determined, in the Low approximation, only by the components of an analogous polarization tensor of a corresponding process without the photon emission. (auth)

41771 (JINR-P2-3856) ON THE HIGH-ENERGY BEHAVIOUR OF THE DIFFERENTIAL CROSS-SECTION OF CERTAIN INELASTIC PROCESSES INVOLVING LEPTONS. Baluni, Varuzhan (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. (In Russian). Dep.

The analyticity of the differential cross section of certain electromagnetic and weak inelastic processes with momentum transfer is proved in a fairly large domain. Some bounds on the behavior of the differential cross section are derived. (auth)

41772 (JINR-P2-3866) APPEARANCE OF THE REGGE POLES WHILE SCATTERING IN THE COULOMB FIELD. Liberman, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 12p. (In Russian). Dep.

The Regge poles, which appear while scattering in the Coulomb field, were considered. It is shown that the Regge "daughter trajectories" are due to the existence of the dynamical symmetry group of the Coulomb problem. (auth)

41773 (JINR-P2-3928) ELECTROMAGNETIC MASS DIFFERENCE OF Ξ-HYPERONS. Dorodnykh, V. S.; Struminskii, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 7p. (In Russian). Dep.

The electromagnetic mass difference of Ξ hyperons was calculated by using the sum rules for a finite energy of a virtual Compton effect. The results agree well with the experimental data. (auth)

41774 (NP-17531) METHOD FOR DERIVING ANGULAR CORRELATIONS FOR PARTICLE PRODUCTION AND DECAY. Note No. 131. Osborne, L. S. (Rome Univ. (Italy). Istituto di Fisica). July 28, 1967. 46p. Dep.

A general method using vector operators is derived to obtain angular correlations between particles produced by collisions and their subsequent decay if present. The expressions are in vector form for easy appreciation. The method is applied to general reactions and decays with specific examples for π-photoproduction, ρ-meson production, N^*-production, ρ-π peripheral production, and 3π production by e^+e^- annihilation. (auth)

41775 ALL THE HADRONIC CONTRIBUTIONS TO THE ANOMALOUS MAGNETIC MOMENT OF THE MUON AND THE LAMB SHIFT IN THE HYDROGEN ATOM. Terazawa, Hidezumi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 39: 1326-32(May 1968).

All the hadronic contributions to the anomalous magnetic moment of the muon and the Lamb shift in the hydrogen atom are examined by the use of the identity, $(J_\mu^\gamma)_{\text{all hadrons}} = \lambda_\rho\rho_\mu + \lambda_\phi\phi_\mu + \lambda_\omega\omega_\mu$, proposed by Kroll, Lee, Zumino, and the upper limits for them are obtained namely $\Delta(\frac{1}{2})(g_\mu - 2)_{\text{all hadrons}} < 2.2 \times 10^{-7}$ and $-(\Delta\nu)_{\text{all hadrons}} < 0.014$ Mc/sec $(2S_{\frac{1}{2}} - 2P_{\frac{1}{2}})$. (auth)

41776 ABSORPTION CORRECTION IN HIGH ENERGY PHOTOPRODUCTION OF π^+. Yano, Tadashi (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 39: 1193-1208(May 1968).

The photoproduction of π^+ in the 2 ~ 4 GeV region is investigated in terms of the distorted wave Born approximation. The effects of the non-small angle πN scattering are examined for the (π,p)-exchange model and the (π,p,ρ)-exchange model. It is shown that in the former case the agreement of the theoretical results with experiment becomes worse than the calculations by Hori, Kawaguchi, and Shimoida with the πN phase shifts which only fit the forward peaks. Remarkable agreement is obtained in the latter case for the πN phase shifts of Perl and Corey and of Minami if the proper choice is made for the ρ-meson coupling constant at each energy. The ρ-meson coupling constant shows the tendency to decrease with increasing energy from the present analysis. (auth)

41777 ELECTROMAGNETIC MASS DIFFERENCE OF KAONS. Tanaka, K. (CERN, Geneva). Nuovo Cim., 56A: 764-70(Aug. 1, 1968).

The $K^+ - K^0$ mass difference is examined, using Weinberg's first sum rule and soft-pion technique. The second sum rule is violated in which case the mass difference becomes logarithmically divergent. It is suggested that depending on the value of the coupling constants that appear in the spectral functions the correct sign of the $K^+ - K^0$ mass difference can be obtained without the σ-terms. (auth)

41778 DISPERSION THEORY OF ELASTIC PHOTON–DEUTERON SCATTERING. Pokorski, S. (Univ. of Warsaw). Acta Phys. Pol., 33: 929-51(June 1968).

The relativistic dispersion theory for the process of elastic photon-deuteron scattering is proposed. Numerical results are presented for the differential cross sections for the scattering in the 0 to 100 MeV region of lab energy of the incident photon. The calculations were performed in the approximation based on the assumption that the dominant role is played by the photodisintegration of deuteron in the low-energy elastic γ–d scattering. The results are in very good agreement with the existing experimental data. (auth)

41779 MAGNETIC MOMENTS OF BARYONS IN A QUARK MODEL. James, K. R. (Univ. of Manchester, Eng.). J. Phys., A, 1: 475-82(July 1968).

Magnetic moments of octet baryons are calculated in a nonrelativistic quark model with scalar binding, using a model for SU(3) breaking developed earlier. Violation of ordinary spin symmetry is also considered, leading to a mixture of spin–orbital states. Consistency relations are derivable. In a special case, restricted to the 56, the results are given explicitly. (auth)

Weak

Refer also to abstracts 41766, 41771, 41799, and 41806.

41780 ON THE WEAK INTERACTION AND THE STRUCTURE OF SAKATON. Hayashi, Takemi; Koide, Yoshio; Ogawa, Shuzo (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 39: 1372-4(May 1968).

Some modifications and specifications are added to the Nagoya model for the structure of the Sakaton, on the basis of the following characteristic features of the weak interaction: universality of the strength of interactions; the baryon–lepton relation which is recognized by the presence of angle θ; and the $\Delta I = \frac{1}{2}$ rule. (L.B.S.)

41781 PHENOMENOLOGICAL APPROACH TO NONLEPTONIC DECAYS. II. Ω^- DECAYS UNDER PARAMETERS FIT TO DECAYS OF OCTET BARYONS. Ohya, Katsuhiko (Nihon Univ., Tokyo); Imoto, Mitsuo; Kawasaki, Shoichiro. Progr. Theor. Phys. (Kyoto), 39: 1268-77(May 1968).

Nonleptonic decays of Ω^--hyperon are discussed in a way consistent with those of octet baryons and K_1^0 meson, under the pole approximation in which the parity-conserving and violating effective interactions are assumed to be $\lambda_{\frac{1}{2}}$-like and $i\lambda_{\frac{1}{2}}$-like, respectively. As for the modes of $\Omega^- \to \Xi^0 + \pi^-$ and $\Xi^- + \pi^0$, their decay rates are consistent with experiment, and owing to the P-wave dominance their asymmetry parameters are very small as follows: $\alpha(\Omega^- \to \Xi^0 + \pi^-) = -0.028 \sim -0.015$. The following relation is obtained for the $\Omega^- \to \Xi^{*0} + \pi^-$ and $\Xi^{*-} + \pi^0$ decays. $\Gamma(\Omega^- \to \Xi^{*0} + \pi^-) = 2\Gamma(\Omega^- \to \Xi^{*-} + \pi^0) = (\frac{1}{12} \sim \frac{1}{10})\Gamma(\Omega^- \to \Xi^0 + \pi^-)$, and $\alpha(\Omega^- \to \Xi^{*0} + \pi^-) = -0.0022 \sim -0.0014$ due to the S-wave dominance. The modes of $\Omega^- \to \Xi + 2\pi$ are also discussed under a simplified assumption. However, in the case of the $\Omega^- \to \Lambda^0 + K^-$ decay, which is P-wave dominant, there explicitly appears a problem which may be related to the difficulty of P-waves estimated under pole approximations alone. (auth)

41782 THREE PROPERTIES OF NONLEPTONIC HYPERON DECAYS. Toda, Azuma (Tohoku Univ., Sendai); Murayama, Akihiro. Progr. Theor. Phys. (Kyoto), 39: 1289-1303(May 1968).

The nonleptonic hyperon decay has the following three properties: (I) the $|\Delta I| = 1/2$ rule holds, (II) (i) $\Sigma^+ \to n + \pi^+$ is the pure p-wave decay, (ii) $\Sigma^- \to n + \pi^-$ is the pure s-wave decay, and (III) the triangle relation of Lee and Sugawara holds. In this paper the following problems are discussed: Does there exist such a simple model which can give a theoretical basis for these three properties? If it does not exist yet, then how can the required model be constructed? For this purpose, four typical examples of models are considered: (I) Pole model, (II) Current algebra model, (III) $\tilde{U}(12)$ symmetry model and (IV) Composite model. It has turned out that no model succeeds in explaining all of the three properties. In particular, the existing models fail to obtain $g_- = 0$ without parameter-fitting. Therefore, whenever one tries to construct a new model on the nonleptonic decay, one must begin with searching how to obtain $g_- = 0$. (auth)

41783 s-WAVE $K\pi$ INTERACTION IN THE K_{l3} DECAY MODE Field, R. C.; Jones, P. B. (Nuclear Physics Lab., Oxford). Phys. Rev. Lett., 21: 327-9(July 29, 1968).

Recent measurements of the $K_{\mu 3}/K_{e3}$ relative branching ratio make possible an evaluation of the matrix element of the divergence of the vector current which is independent of f_+. The matrix element of the divergence does not depend on the mass of a possible intermediate vector boson W. The experimental data are best fitted by a resonance in the isospin-$1/2$ s-wave $K\pi$ system in the interval 750 to 1200 MeV. (auth)

41784 IMPLICATIONS OF UNEQUAL CHARGE ASYMMETRY IN $K_L^0 \to \pi^\pm e^\mp \nu$ AND $K_L^0 \to \pi^\pm \mu^\mp \nu$. Sehgal, L. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 21: 412-14 (Aug. 5, 1968).

The possibility is considered that the charge asymmetries δ_e and δ_μ in the decays $K_L^0 \to \pi^\pm e^\mp \nu$ and $K_L^0 \to \pi^\pm \mu^\mp \nu$ might turn out to be different. Some implications, including a test of CPT, are pointed out. (auth)

41785 PHENOMENOLOGICAL APPROACH TO NONLEPTONIC DECAYS. I. SCATTERING-LIKE STRUCTURE AS A BACKGROUND OF VECTOR POLE DOMINANCE IN S-WAVES, AND A PROBLEM OF P-WAVES. Imoto, Mitsuo; Ohya, Katsuhiko (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 39: 1233-67(May 1968).

Taking account of the complicated dual nature of the nonleptonic phenomena in which strong and symmetry-breaking interactions play essential roles as well as primary weak interactions, a systematic and steady phenomenological approach is proposed from the side of emphasizing a parallelism to strong hadronic scattering. The first step of this phenomenological approach (Part I) is attempted by the pole approximation only as a working hypothesis, taking octet-, decuplet-, and Y_1^*-baryon poles as well as octet pseudoscalar, nonet vector and scalar k-meson poles. The parity-violating amplitudes agree better with the $i\lambda_7$-like effective weak interactions than λ_6-like ones. Moreover, in the case of $i\lambda_7$-type the background on which the "vector boson pole dominance" approximation holds is found to be the baryon pole damping similar to that in low energy S-wave πN scattering. On the other hand the parity-conserving amplitudes agree with experiment only through the λ_6-like effective interaction under the f/d ratio of weak interaction ξ_c that deviates from the f/d ratio of mass-splitting ξ_M. Some contradiction is found, however in the ideal limit $\xi_c = \xi_M$ which is expected on those theories that unify the λ_6-like parity-conserving effective weak interaction with the $i\lambda_7$-like parity-violating one. Thus it is suspected that the main part of parity-conserving amplitudes does not come from the graphs developed into the pole terms, at least in the same order symmetry-breaking as that giving a consistent solution for parity-violating amplitudes. (auth)

41786 VECTOR MESON DOMINANT MODEL AND THE $K \to \pi e^+ e^-$ DECAY. Tsai, S. Y. (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 39: 1223-32(May 1968).

The $K \to \pi e^+ e^-$ decay is investigated under the vector meson dominant model of the electromagnetic interaction of hadrons. To the extent that this model describes the actual process, the following results were obtained: (i) the breakdown of the SU(3) symmetry at the photon-vector meson vertices may be such that it enhances the $\gamma-\omega$ coupling strength but greatly reduces the $\gamma-\phi$ coupling strength; (ii) the K-π weak vertex function is almost momentum independent; (iii) the decay rates for $K^+ \to \pi^+ e^+ e^-$ and $K_L^0 \to \pi^0 e^+ e^-$ are equal; and (iv) the branching ratio for $K^+ \to \pi^+ e^+ e^-$ turns out to be of order 10^{-10}. (auth)

41787 ON NONLEPTONIC DECAYS. A POSSIBLE SCHEME FOR J^+J-TYPE WEAK INTERACTION PICTURE. Furui, Shin-ya; Tsuchida, Tetsuya; Fujii, Kanji; Kawasaki, Shoichiro (Ibaraki Univ., Mito, Japan. Hokkaido Univ., Sapporo. Chiba Univ., Japan). Progr. Theor. Phys. (Kyoto), 39: 1278-88(May 1968).

A possible interrelation between ordinary current × current (J^+J-type) picture and phenomenological two-body weak interaction in nonleptonic weak decays is investigated. The investigation is based on $U^{-1}\partial_\alpha L_\alpha(x)U = \partial_\alpha L_\alpha(x) + \int [L_4(x), H_{strong}(y,x_0)]d^3y$, where $L_\alpha(L_{\dot{\alpha}})$ means an operator in the interaction (Heisenberg) representation and U the unitary operator connecting these two representations. The strong interaction is assumed to be given as products of appropriate (V,A) currents. In the fundamental triplet model the two-body weak interaction can be internally connected with the ordinary J^+J-type weak interaction. This interrelation requires both symmetric and symmetry-breaking interactions (which are assumed to be of octet current × octet current-type) of the form $G_V V \cdot V + G_A A \cdot A$ with $G_V = G_A$, where V(A) denotes a vector (axial-vector) current. At the hadron level, similar discussions are developed and a parallelism can be obtained between triplet and hadron cases considering the weak interaction with $|\Delta I| = 1/2$. It is to be noted that as for the $|\Delta I| = 3/2$ part no connection was found between two-body weak interaction and J^+J-type interaction it is concluded that the weak interaction with $|\Delta I| = 3/2$ has a structure essentially different from the one with $|\Delta I| = 1/2$. (auth)

41788 THE MASS DIFFERENCE OF THE NEUTRAL KAONS AND THE DECAY $K_2^0 \to \gamma\gamma$. Greenberg, D. F. (Univ. of Chicago). Nuovo Cim., 56A: 597-603(Aug. 1, 1968). (COO-264-420).

The current-current form of the weak Hamiltonian is used, in a pole-dominance model, to study the mass difference of the neutral kaons, and the decay $K_2^0 \to \gamma\gamma$. (auth)

41789 BREMSSTRAHLUNG IN $K \to 3\pi$ DECAYS. Ferrari, R.; Rosa-Clot, M. (Scuola Normale Superiore, Pisa, Italy). Nuovo Cim., 56A: 582-96(Aug. 1, 1968).

The emission of a photon by bremsstrahlung is calculated for the charged $K \to 3\pi$ decays considering the dependence on the pion energies of the amplitudes for the nonradiative processes. The theory developed by Low is used, which gives the spectrum of the photon up to zeroth order in the frequency, in the limit of low energy. For the radiative τ-decay this technique yields corrections of 10 percent to the results obtained by Dalitz which assumed a constant amplitude for the nonradiative process. A theorem is given which brings considerable simplifications when applying Low's theory for bremsstrahlung. (auth)

41790 NOTE ON RADIATIVE CORRECTIONS TO β-DECAY. De Alwis, S. P. (Cambridge Univ., Eng.). Nuovo Cim., 56A: 793-4(Aug. 1, 1968).

The radiative corrections to the decay $n \to p + e^- + \bar{\nu}$ arising from three Feynman diagrams is considered. The contribution of the diagram for which the interaction of the lepton pair is nonlocal to the remaining two amplitudes is briefly examined. (L.B.S.)

41791 ON THE MOTION AND STATISTICS OF NEUTRINOS IN SUPERDENSE MATTER. Kuchowicz, Br. (Univ. of Warsaw). Acta Phys. Pol., 33: 723-31(May 1968).

The motion of neutrinos in various theoretically possible types of internal stellar fields is studied; the results of studies (which have been partially reported in preceding papers) are summarized. For strong enough gravitational fields inside (and in a vicinity of the surface) of the star the neutrino emission into outer space may be rendered difficult owing to the "gravitational trap" mechanism. Since inside a superdense star more and more neutrinos accumulate in equilibrium with other elementary particles, the problem of neutrino statistics arises. The gravito-dynamical and the statistical approaches to the neutrino problem in superdense stars may be regarded as being complementary. (auth)

41792 TADPOLE MODEL FOR NONLEPTONIC DECAYS BASED ON CURRENT-ALGEBRA AND SPECTRAL-FUNCTION SUM RULES. Kumar, A.; Pandit, L. K. (Tata Inst. of Fundamental Research, Bombay). Nuovo Cim., 56A: 771-80(Aug. 1, 1968).

A tadpole model for the nonleptonic decays based on a scalar $\varkappa$ field proportional to the divergence of the strangeness-changing vector current-density, and on the pseudoscalar mesons π and K satisfying PCAC, is studied by use of the current-algebra and spectral-function sum rules. A reasonably good fit to the hyperon decay data is obtained. (auth)

41793 CALCULATION OF THE LEPTONIC DECAY WIDTH OF ρ^0 AND ω^0 MESONS IN A NUCLEON–ANTINUCLEON COMPOSITE MODEL. Andriambololona, Raoelina; Bourrely, C. (CNRS, Marseille). Nuovo Cim., 56A: 646-58(Aug. 1, 1968).

In a $(N-\bar{N})$ composite model of vector mesons the partial width corresponding to a leptonic decay mode (e^+e^- or $\mu^+\mu^-$) was evaluated, and an application to ρ^0 and ω^0 mesons is investigated. Numerical calculation of the partial width is given using only for the composite mesons the parameters which have been pre-

viously determined in the strong-interaction scheme. For the ρ^0-meson the obtained values are in good agreement with the experimental results, but for the ω^0 the obtained values are much greater. (auth)

41794 STATUS OF THE CABIBBO THEORY. Brene, N. (CERN, Geneva. Niels Bohr Inst., Copenhagen); Roos, M.; Sirlin, A. Nucl. Phys., B6: 255-72(1968).

The Cabibbo theory of semileptonic processes is examined on the basis of recent experimental and theoretical results. Although the gross features of the experimental situation conform with the theory, the detailed analysis is not completely satisfactory at the present time. Thus, the K_{e3} decay rates, the neutron lifetime, the Ξ^- beta-decay rate, the asymmetry $\alpha_{\Sigma^-_e}$ ($\Sigma^- \rightarrow n + e + \nu$), and the ^{26}Al ft value require explanation or further precise experimentation. The problem of universality of weak interactions is discussed on the basis of two models which assume the validity of current algebra at small distances and for which the second-order radiative corrections to G_V/G_μ are finite: the first assumes a special form for the space–space part of the current algebra, the second assumes the existence of the intermediate boson. Although the present experimental situation as described by the ^{14}O data is consistent with both models, it is possible that a clarification of the K_{e3} decay rates and the "^{26}Al problem," as well as precise calculations of symmetry-breaking corrections to K_{e3} amplitudes, may discriminate against one of them. The need for accurate calculations of second order symmetry breaking effects to vector matrix elements and of electromagnetic corrections of order $Z\alpha^2$ is emphasized. (auth)

41795 THIRD NEUTRINO HYPOTHESIS. Romanov, Yu. I. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 127-9(1968). (In Russian).

There were not enough kaons in the pion beam neutrino experiments carried out at the Brookhaven National Laboratory and at CERN to confirm or to disprove the existence of the third neutrino on the basis of reactions involving high-energy neutrinos. According to Dirac's four-component theory, in the various ($K^+ - \mu^+$) and ($K^+ - e^+$) decays left-polarized muon-antineutrino and electron-neutrino are formed together with muons and positrons, respectively; however, hadronic neutrinos may also be emitted, regardless whether the strangeness is conserved or not. Examination of the polarization properties of leptons resulting from the interaction of hadronic and leptonic components indicates that the spiral nature of the positrons formed may, under certain conditions coincide with that of the hadronic antineutrino (neutrino); thus, both positrons and muons could be left-polarized. A closer study of the polarizing properties of leptons in beams opposing electrons (muons) and neutrinos from various ($K - \mu$) and ($K - e$) decays would allow one to determine the spiral properties of electrons, muons, and hadronic neutrinos. This problem could be clarified by experiments on one of the most modern accelerators. (TTT)

Strong (General)

41796 (ISS-68/11) WIDTH OF HADRONS. Matthiae, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Apr. 15, 1968. 13p. Dep.

A calculation of the average value of the width of hadrons as a function of their mass is reported. The approach, which makes use of the mass spectrum of hadrons as predicted by the thermodynamical model, is based on the application of detailed balance. (auth)

41797 ANOTHER CONVERGENT, RELATIVISTIC MODEL THEORY OF INTERACTING PARTICLES. RELATIVISTIC VERSION OF A MODIFIED LEE MODEL. Kita, Hideji (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1333-60(May 1968).

The existence of a unitary representation of the inhomogeneous Lorentz group, which corresponds to a relativistic version of a modified Lee model, is proved through the process of actual construction of a set of ten generators ($P_\mu, M_{\mu\nu}$) in terms of creation- and annihilation-operators of three kinds of particles. The model theory contains ab initio a cutoff form factor which is kept throughout the whole scheme of the formalism, as it stands. The cutoff form factor is a function only of the invariant square of momentum transfer at the primary interaction vertex. By virtue of the cutoff form factor the theory has no divergence difficulties. The total Hamiltonian, $H(\equiv -iP_4)$, of the model contains, from the very beginning and in an inevitable way, a finite "mass-renormalization term." The inclusion of that term in the Hamiltonian is inevitable in order for the ten generators to satisfy the set of fundamental commutator equations. Thus it turns out that the "mass-renormalization term" subtly takes its proper place within the realm of the formalism. (auth)

41798 TOTAL CROSS SECTION FOR n-PARTICLE PRODUCTION IN A MULTI-REGGE MODEL. Finkelstein, J.; Kajantie, K. (CERN, Geneva). Nuovo Cim., 56A: 659-80(Aug. 1, 1968).

The total cross section $\sigma_n(s)$ for n-particle production in a multi-Regge model is analysed in detail as a function of both multiplicity and total energy, using special techniques for the phase-space integration. It is shown that repeated exchange of the vacuum trajectory, even with finite slope, would lead to a cross section which increased without bound as $s \rightarrow \infty$. The application of the results to analysis of experimental data is discussed. (auth)

41799 NATURE OF UNIVERSAL PRIMARY INTERACTIONS OF PARTICLES. Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Proc. Roy. Soc. (London), Ser. A, 305: 319-43(July 1968). (NYO-3399-137).

A theory of primary interactions between elementary particles is proposed. It is based on the hypothesis that these are three primary interactions: weak, electromagnetic, and strong; and each is characterized by a single coupling constant. The primary weak interactions couple the leptons to themselves and to vector and axial vector fields, but not to nucleons. The primary electromagnetic interactions couple the electromagnetic field to the charged leptons or to the neutral vector meson fields, but not to nucleons. The primary strong interactions couple the vector and axial vector fields to the nucleons. All the couplings are universal. On the basis of this theory it is possible to account quantitatively for the anomalous magnetic moments of the nucleons, the ratio of the Gamow–Teller and the Fermi β decay coupling constants, weak magnetism, absence of neutral lepton currents, pion-decay, pion-nucleon scattering lengths, and the principal features of the nuclear force. The theory, when extended to strange particles, leads automatically to the suppression of weak decays of strange particles. The older chirality invariant V–A four fermion interaction is recovered as the effective interaction for small momentum transfers. No intermediate bosons in the conventional sense are required or expected. The application to the absolute calculation of electromagnetic mass shifts and nonleptonic decay rates yields finite answers. (auth)

41800 FACTORIZATION QUARK MODEL FOR LARGE MOMENTUM TRANSFER SCATTERING. Weiner, Richard M. (Univ., Bucharest). Nucl. Phys., B6: 226-32(1968).

Processes of the type $A + B \rightarrow C + D$ are considered in a quark model in which all quarks interact simultaneously. It is assumed that at high energies and large momentum transfer the scattering amplitudes add incoherently and that the quark–quark scattering probabilities do not depend on the helicity state of the quarks involved. Simple relations between cross sections are obtained which could serve as tests of the present model. (auth)

41801 STRONG INTERACTIONS EXPERIMENTAL ASPECTS. Goldhaber, G. (Univ. of California, Berkeley). pp 163-324 of Proceedings of the Second Hawaii Topical Conference in Particle Physics, University of Hawaii, Honolulu. Pakvasa, S.; Tuan, S. F. (eds.). Honolulu, Hawaii, University of Hawaii Press, 1968.

See CONF-670841.

A review of the L = 1 $q\bar{q}$ nonets covering the K^*'s of the L = 1 nonets, the structure of the $K\pi\pi$ mass distribution, interference phenomena in the $K\pi\pi$ mass distribution, K^* mixing, the $\pi\rho$ boson cluster in the A_1, A_2 region, and the $J^{PC} = 0^{++}$ states $^3P_0$ is given. Higher mass boson and baryon multiplets, the search for higher boson and baryon multiplets, the low-energy scattering length and coupling constants, SU(3) decay constants for baryon resonances, and elastic scattering and charge exchange cross sections are also reviewed. A large number of tables, diagrams, and references are included. (J.F.P.)

41802 HADRON SPECTROSCOPY. Dalitz, R. H. (Oxford Univ.). pp 325-466 of Proceedings of the Second Hawaii Topical Conference in Particle Physics, University of Hawaii, Honolulu. Pakvasa, S.; Tuan, S. F. (eds.). Honolulu, Hawaii, University of Hawaii Press, 1968.

See CONF-670841.

The review of hadron spectroscopy includes hadronic substructure, triplets and quarks, classification of interactions and selection rules, mesonic states, and baryonic states, in particular, the $L = 0^+$ supermultiplet. The $L = 1^-$ baryon supermultiplet, and also other excited baryonic supermultiplets are discussed. (J.F.P.)

Strong (Baryon No. = 0)

Refer also to abstracts 41757, 41847, and 41859.

41803 (CALT-68-162) MESON CLASSIFICATION IN THE QUARK MODEL. Zweig, George (California Inst. of Tech.,

Pasadena). Apr. 1968. Contract AT(11-1)-68. 14p. (CONF-680428-8). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

The current status of the quark model for classification of low-lying meson states is examined. The discussion covers the questions of whether a harmonic oscillator potential or, more generally, the quantum number n is needed; that is, whether there are any radial vibrations; also whether all quark spin singles (S = 0) objects fall into octets plus singlets with a $(\text{mass})^2$ structure similar to the pseudoscalar mesons, whether triplet states (S = 1) always form nonets with a $(\text{mass})^2$ structure like the vector mesons; the variation of the $\vec{S}\cdot\vec{S}$ interactions with (n,L); and the variation of the $\vec{L}\cdot\vec{S}$ interaction with (n,L) are considered. (J.F.P.)

41804 (JINR-P2-3859) RELATIVISTIC MODEL OF MESON RESONANCES WITH A LINEAR SPECTRUM. Matveev, V. A.; Muradyan, R. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 8p. (In Russian). Dep.

A linear dependence between the spin and the square of a compound particle mass was obtained from the relativistic equation for the fermion–antifermion system. The result is applied for classification of the heavy meson resonances with I = 1, which go into four straight-line Regge-trajectories, considered previously by Dalitz. It also follows from the model that the parameters, which determine the trajectory slopes, are connected by the ratios: $\alpha'\pi(0) = \alpha'_{A_1}(0)$ $[1/\alpha'\rho(0) + 1/\alpha'\pi_\tau(0) = 2/\alpha'\pi(0)]$ which are valid for a chosen position of particles on the trajectories. (auth)

41805 (JINR-P2-3879) UNITARY-SYMMETRY THEORY OF MULTIPLE PARTICLE PRODUCTION. Barashenkov, V. S.; Zinov'ev, G. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 33p. (In Russian). Dep.

A statistical model was suggested in which the particles are considered as terms of SU_3-multiplets and the transitions are possible only between the states which correspond to the same irreducible representations of the SU_3 group. The $p - \bar{p}$ and $\bar{p} - n$ annihilations at rest and inelastic π^+p interactions in the energy range T > 1 GeV are considered in detail. (auth)

41806 (SINP-TH-67-18) A MODEL FOR π-π SCATTERING IN THE I = J = 0 CHANNEL. Banerjee, H.; Dutta-Roy, B.; Menon, V. J. (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [1967]. 13p. Dep.

It is shown that the recent data on $K_{\mu 4}$ decay and the 3π decay modes of η and K^0_L admit of satisfactory interpretations in terms of a model for $\pi\pi$ scattering in the I = J = 0 channel suggested by an analysis of the backward π-N dispersion relations. (auth)

41807 (UCRL-18266) ARE THERE ANY FAR-OUT MESONS OR BARYONS? Rosenfeld, Arthur H. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 29p. (CONF-680428-9). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

Evidence for far-out (in weight space) mesons and baryons is considered. It is shown that the number of claims corresponds reasonably well to the number of statistical fluctuations that one would expect. If far-out mesons are being produced, their cross sections are below the 10 μb level. Properties of far-out mesons ($|Q|$ or $|I| \geq 3/2$ cannot be formed from quark–antiquark pairs), absence of evidence for the exchange of virtual far-out mesons, the periodic appearance of 4σ fluctuations in some channel, the absence of direct evidence, a summary of far-out spectra, the status of far-out baryons, and the uncertainty in $K^+ + n \to Z_0$ (1865) and $K^+ + p \to Z_1$ (1900) are covered. A prescription for the identification of a resonance is also given. (J.F.P.)

41808 SPIN-PARITY TEST FOR FOUR-PION RESONANCES. Nyborg, P.; Dotson, A. C.; Good, R. H. Jr. (Ames Lab., Iowa). Nuovo Cim., 56A: 719-36(Aug. 1, 1968). (IS-1755).

A method is presented to help determine the spin-parities of zero-isospin meson resonances which are produced with no net polarization and which decay directly into four pions. The number of decay events is considered as a function of the angle between the planes of the two emerging dipions, and it is found that the form of this function depends somewhat on the spin-parity of the resonance. Results are given for $J^P = 0^+, 1^+, 2^+$, and 3^-; each of the two admissible types of symmetries in the momenta, or energies, of the four pions is treated. Although some spin-parities are found to give the same type of angular dependence, the use of this method could eliminate certain J^P assignments from consideration, for a given resonance. (auth)

41809 A_1-π MIXING AND PRODUCTION OF A_1 MESONS BY DIFFRACTION DISSOCIATION OF PIONS. Sweig, Mitchel J.; Wada, Walter W. (Ohio State Univ., Columbus). Contract AT(11-1)-1545. Phys. Rev. Lett., 21: 414-17(Aug. 5, 1968).

A mixing model based on current-field identity is used to evaluate the coupling constant for the off-mass-shell transition $A_1 \to \pi$. Using either the Weinberg relations and the Kawarabayashi–Suzuki–Riazuddin–Fayyazuddin relation or the Goldberger–Treiman relation, $g_{A_1\pi} = m_{A_1}$ is found. The cross section for production of A_1 by pions on heavy nuclei is estimated with the assumption that diffraction dissociation is the most important mechanism by analogy to ρ^0 photoproduction. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 41774, 41807, 41839, 42098, 42107, 42108, and 42141.

41810 (INR-P-915) STUDIES ON FIREBALL MODEL. Miesowicz, M. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 35p. (CONF-680319-1). Dep.

From Meeting on the Fireball Model, Moscow, USSR.

Experimental facts are discussed which can be interpreted in terms of fireball emission in hadron interactions with energies in the interval 10 to 10^5 GeV. A detailed analysis of emulsion experiments at energies 10^3 GeV to 10^4 GeV is presented. A discussion of the role of isobars in particle production at $\sim 10^3$ GeV is given. Limitation on isobar mass and decay multiplicities resulting from observed anisotropy of pionization particles are discussed. The possibility of investigation of the physical nature of fireballs by studying interactions of nucleons with heavy nuclei is discussed. (auth)

41811 P AND P' FROM HIGH-ENERGY SUM RULES. Grecchi, V. (Univ., Florence); Turchetti, G. Nuovo Cim., 56A: 786-9(Aug. 1, 1968).

A sum rule proposed by Gatto (Nuovo Cimento, 51: 212(1967)) is applied to the forward πN elastic scattering amplitude in order to obtain the parameters for P and P' Regge poles. It is concluded that an effective description in terms of P and P' is consistent with high-energy data and with low-energy implications from analyticity. (L.B.S.)

41812 TWO-PION EXCHANGE CONTRIBUTIONS TO THE K^+-p POTENTIAL. Diederich, S. (Univ., Giessen, Ger.). Z. Phys., 213: 233-43(1968).

Employing perturbation theory a K^+-meson proton potential resulting from two-pion exchange is obtained. Recoil effects are taken into account. For short distances a phenomenological hard core interaction is added and s-wave phase shifts are calculated. (auth)

41813 $O_{3,1}$ SYMMETRY AND THE PRODUCTION OF Δ^{2+} (1238) AT HIGH ENERGY. Nath, L. M. (Purdue Univ., Lafayette, Ind.); Korthals Altes, C. P. Nuovo Cim., 56A: 558-66(Aug. 1, 1968). (COO-1428-39).

A partial-wave analysis of the reaction $\pi^+ + p \to \pi^0 + \Delta^{2+}(1238)$ is presented in terms of the homogeneous Lorentz group $O_{3,1}$. Theoretical expectations on the momentum transfer distribution of the differential cross section and the polarization of the produced $\Delta^{2+}(1238)$ were compared with the experimental results as well as the predictions from previous works. This analysis reproduces the characteristic experimental features quite well. (auth)

41814 K^+-p ELASTIC SCATTERING AT 3.5 AND 5 GeV/c. Minami, Shigeo; Shigeta, Kazuo (Osaka City Univ.). Progr. Theor. Phys. (Kyoto), 39: 1209-18(May 1968).

K^+-p elastic scattering at 3.5 and 5 GeV/c is described in terms of the amplitudes due to the diffraction, ρ-exchange and hyperon-exchange. By using this model the experimental results for $d\sigma/d\Omega$ can well be explained. Moreover, it is pointed out that the properties of $d\sigma/d\Omega$ in a region from $\cos\theta = -0.4$ to -0.7 depend strongly on the interference between the amplitudes due to the ρ-exchange and hyperon-exchange. Polarization of recoil protons in forward scattering is predicted with the same model. (auth)

41815 NEW SUM RULE FOR πN SCATTERING AND THE REGGE POLE MODEL. Sato, Hikaru (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 39: 1219-22(May 1968).

A new sum rule of superconvergent type is derived for the πN helicity-nonflip amplitude and is examined experimentally. It is found that the sum rule is well satisfied under the assumption of the P- and P'-Regge pole dominance model. (auth)

41816 COMPOSITE MODEL AND REGGE POLE. Machida, Shigeru; Yoshida, Toshihiro (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1304-18(May 1968).

Relations between the composite models and the Regge behaviors of the hadrons are discussed. Composite particles are expected to show Regge behaviors owing to the smoothness of the dependence on angular momentum of the "force" acting between the constituent particles. π^-p charge exchange scattering with the ρ-trajectory is analyzed explicitly. Taking the quark model as an example the crossed channel quark-antiquark scattering amplitude is Reggeized by the use of the additivity assumption; the crossing relation between the direct channel quark-quark or quark-antiquark amplitudes and the crossed channel amplitudes is also Reggeized. Calculated results are insensitive to the mass of the quark, and the trajectory agrees with experimental values for $|t| \lesssim 1$ (GeV/c)^2. The residue of the ρ-trajectory appearing in the S-matrices for quark-quark and quark-antiquark scattering, b(t), varies slowly with t. The residue in the S-matrix for π^-p charge exchange scattering is obtained by multiplying b(t) by the form factors of the composite hadrons, and it turns out that the resulting residue function has an exponential dependence on t, which is required to fit the experimental data. The magnitude of the exponent agrees very well with the one determined by other experimental data. It is conjectured that the residue function of the Regge poles appearing in the S-matrix for hadron-hadron scattering reflects the compositeness of the hadrons directly and is determined by the spatial extension of the wave function of the constituent particles in the hadrons. (auth)

41817 EVIDENCE FOR LINEAR EXTRAPOLATIONS OF BARYON-EXCHANGE TRAJECTORIES THROUGH PARTICLE MASS SPECTRA. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett., 21: 392-4(Aug. 5, 1968). (COO-881-163).

The N_α and Δ_δ Regge-trajectory functions in the scattering region are obtained from analysis of new data on backward $\pi^\pm p$ elastic scattering. At small $|u|$, the intercepts and slopes of both trajectories agree with straight-line extrapolations $\alpha = a + bu$ through the baryon masses. In the large $|u|$ region, the trajectories appear to be leveling off. (auth)

41818 PROPERTIES OF THE P AND P′ REGGE TRAJECTORIES FROM LOW-ENERGY πN AND KN SCATTERING AMPLITUDES. Gilman, Frederick J. (Stanford Univ., Calif.); Harari, Haim; Zarmi, Yair. Phys. Rev. Lett., 21: 323-7(July 29, 1968).

It is shown that the resonance-dominance approximation for the low-energy part of finite-energy sum rules for the C = +1, I = 0 t-channel πN and KN elastic amplitudes reproduces correctly properties of the P′ trajectory and residue functions. The Pomeranchukon is fully accounted for by the low-energy background. The Gell-Mann ghost-eliminating mechanism is favored for the P′ trajectory. (auth)

41819 PHENOMENOLOGICAL BARYON–MESON INTERACTION LAGRANGIAN THAT IS INVARIANT AGAINST THE CHIRAL GROUP SU(3) x SU(3). Volkov, D. V. (Physical-Technical Inst., Kiev). JETP Lett. (USSR)(Engl. Transl.), 7: 303-8(May 20, 1968).

A phenomenological Lagrangian for baryon interactions with pseudoscalar mesons is constructed, which is invariant under the chiral SU(3) × SU(3) group. The octet of pseudoscalar mesons and the baryon octet are considered. (L.B.S.)

41820 PROTON HALO AND ANTIBOUND STATES. Fil'kov, L. V. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR)(Engl. Transl.), 7: 275-8(May 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 352-5(May 5, 1968).

The existence of a virtual level in the p-wave of the system of two virtual π mesons is postulated, which leads to the occurrence of a proton halo. It is noted that this level should become manifest also in the processes $\pi\pi \to \pi\pi$, $\gamma\pi \to \pi\pi$, $\pi N \to \pi N$, $\gamma N \to \pi N$, etc. It is also noted that virtual levels can exist in principle in a three-pion system, leading to the existence of a halo of the isoscalar part of the nucleon. (L.B.S.)

41821 LIMIT FOR THE RATE OF DIRECT MUON PRODUCTION IN HIGH-ENERGY NUCLEAR INTERACTIONS. Sitte, K. (Univ., Freiburg i. B. Univ., Turin); Dardo, M.; Penengo, P. Nuovo Cim., 56B: 349-51(Aug. 11, 1968).

Attention is drawn to a possible connection between the observation of the presence at 70 MWe underground of strongly interacting particles, arriving with delays of the order of 10 to 20 ns in showers of penetrating particles, presumably muons, and the lacking sec θ enhancement in the angular distribution of very energetic muons reported previously. It is concluded that an isotropic component exists among the energetic penetrating particles. A new kind of interaction process involving direct muon production is discussed. It is concluded that even if this process is responsible for some 80% of all energetic muons, it need occur only in less than 10% of all interactions. (J.F.P.)

41822 ON THE ROLE OF ρ EXCHANGE IN LOW-ENERGY πN SCATTERING. Hoehler, G.; Baacke, J.; Steiner, F. (Univ., Karlsruhe, Ger.). Z. Phys., 214: 281-7(1968).

It is pointed out that important features of the low energy πN charge-exchange amplitude differ considerably from the prediction of the ρ-dominance model. Without further improvements the Cini-Fubini approximation does not lead to a reliable determination of the ρ-coupling constants. (auth)

41823 PRODUCTION OF PSEUDOSCALAR MESONS IN THE COULOMB FIELD OF THE NUCLEUS AND THE POSSIBILITY OF OBSERVING THE PHOTOPRODUCTION OF MESONS FROM MESONS. Iroshnikov, G. S.; Nikitin, Yu. P. (Moscow Engineering Physics Inst.). JETP Lett. (USSR)(Engl. Transl.), 7: 311-13(May 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 393-6(May 20, 1968).

The possibility of observing photoprocesses of the type $\gamma + P \to P + P$ in the Coulomb field of the nucleus from reactions of the type $P + Z \to P + P + Z$ is studied. An analysis is made for the case of the xenon nucleus and pseudoscalar mesons. (L.B.S.)

Strong (Baryon No. ≥ 2)

Refer also to abstract 41810.

41824 (DESY-68/32) A NEW PROCESS IN ULTRA-HIGH-ENERGY INTERACTIONS. Lohrmann, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). June 1968. 8p. Dep.

It is shown that the results of two high energy cosmic ray experiments can be correlated and lend mutual support to the indication that a new mechanism leading to the copious production of ϕ-mesons starts above 10^{12} eV. Further possible experiments to see this effect are discussed. (auth)

41825 (IC-68/1) ANALYSIS OF THE $\Lambda\Lambda$ HYPERNUCLEUS $_{\Lambda\Lambda}C^{14}$. Ali, S.; Kok, L. P.; Grypeos, M. E. (International Centre for Theoretical Physics, Trieste (Italy)). Jan. 1968. 17p. Dep.

An analysis was made of the yet unobserved $_{\Lambda\Lambda}C^{14}$ system in a Λ-Λ-C^{12} model using Λ-Λ interactions quite reliably determined from the analysis of $_{\Lambda\Lambda}He^6$. Allowance was made for distortion of the core by the two Λ particles. The sensitivity of the results for $\Delta B_{\Lambda\Lambda} = B_{\Lambda\Lambda} - 2B_\Lambda$ to the nuclear compressibility coefficient was explored, and the role of the $\Lambda\Lambda$-hypernucleus as a possible probe into this coefficient was discussed. Finally the importance of an accurate experimental determination of $B_{\Lambda\Lambda}(_{\Lambda\Lambda}C^{14})$ was stressed. (auth)

41826 $^6He_{\Lambda\Lambda}$ WITH NONLOCAL SEPARABLE INTERACTIONS WITH HARD SHELL $\Lambda-\Lambda$ REPULSION. Dabrowski, J.; Dworzecka, M.; Trych, E. (Univ. of Warsaw). Acta Phys. Pol., 33: 831-8(May 1968).

The problem of $^6He_{\Lambda\Lambda}$ treated as a $2\Lambda + \alpha$ system is solved exactly with a Yamaguchi nonlocal separable $\Lambda-\alpha$ potential, $V_{\Lambda\alpha}$, and a nonlocal separable $\Lambda-\Lambda$ potential, $V_{\Lambda\Lambda}$, consisting of a long range attractive part plus a repulsive shell of radius c. The parameters of $V_{\Lambda\alpha}$ and $V_{\Lambda\Lambda}$ are adjusted to make the potentials equivalent to the local potentials $V_{\Lambda\alpha}$ and $V_{\Lambda\Lambda}$ (with hard core radius r_c) discussed recently by Tang and Herndon. Numerical results for $B_{\Lambda\Lambda}$ ($^6He_{\Lambda\Lambda}$) show that to get agreement with the experimental value of $B_{\Lambda\Lambda}$ one has to choose $c < r_c$. (auth)

41827 CHARGE-EXCHANGE SCATTERING OF POSITIVE PIONS BY ^{3}He. Sakamoto, Y. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim., 56A: 694-700(Aug. 1, 1968).

The energy-integrated cross section of the charge-exchange scattering of pions is calculated at the pion energy of the (3,3) resonance. The cross section is closely related to form factor. The cross section at backward angles depends on the form factor at the region of large momentum-transfers and hence sheds light on the short-range correlation of nucleons in nuclei. (auth)

41828 THRESHOLD CALCULATION OF NN → NNπ. Beder, D. S. (CERN, Geneva). Nuovo Cim., 56A: 625-45(Aug. 1, 1968).

Soft-pion techniques, together with the tractable approximation of considering only emission from external nucleon lines, are used for a calculation of NN → NNπ near threshold. The results vary from 1.2 to 3 times the experimental data. A similar calculation of pp → π^+d is within 25% of experimental cross-section data. Finally, a relation (independent of soft-pion techniques) between pp → π^+d and pp → π^+np is obtained. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 41752.

41829 (JINR-P2-3858) FIELD ALGEBRA AND SU(2) × SU(3) × T_{24} SYMMETRY GROUP. Matveev, V. A.; Muradyan, R. M.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 10p. (In Russian). Dep.

The commutation relations of the field algebra are used to describe the states of particles at rest. There appears, naturally, instead of the SU(6) algebra, the system of commutation relations of the Lee algebra of the SU(2) × SU(3) × T_{24} group, obtained previously in the strong coupling theory. In particular, in the axial current the ratio d/f is found to be 3, which disagrees with the result of SU(6) and agrees both with that of the superconvergent dispersion sum rules and with the hypothesis of nonadditive quark currents. (auth)

41830 TWO-DIMENSIONAL EUCLIDEAN GROUP AND THE PARTIAL-WAVE EXPANSION. I. Miyazaki, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 39: 1319-25(May 1968).

When the invariant amplitude f(s,t) is decomposed into the partial-wave scattering amplitudes for fixed t, four different cases must be considered according to the values of t. The amplitude f(s,t) is considered as a function over a little group. For t = 0, two cases occur; the case is treated where the little group is two-dimensional Euclidean group E_2. Taking f(s,t = 0) as a function over E_2, the partial-wave expansion is obtained according to the unitary irreducible representations of E_2 and the Regge behavior can be selected from this expansion. It is found that this group-theoretical method is essentially the "eikonal" approximation representation. (auth)

41831 REALIZATION OF POINCARE-GROUP GENERATORS ON A LIGHT CONE. Peres, Asher (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 9: 785-9(May 1968).

The ten generators of the proper inhomogeneous Lorentz group are explicitly constructed for spin-0 and spin-½ particles, in the case when wavefunctions are given on a light cone (rather than on an equal time hypersurface, as usual). The advantage of this formulation is that the generators J (spatial rotations) and K (Lorentz boosts) involve only elementary local operators. The Hamiltonian H and momentum operators P also contain the inverse radial momentum $(\partial/\partial r)^{-1}$, but do not involve any square roots. Moreover, only two-component spinors are required for spin-½ particles. (auth)

41832 PROPERTIES OF HIGHER-ORDER COMMUTATOR PRODUCTS AND THE BAKER-HAUSDORFF FORMULA. Eriksen, Erik (Univ. of Oslo, Blindern, Norway). J. Math. Phys. (N. Y.), 9: 790-6(May 1968).

The element $z = \log e^x e^y$, which is known to be an element of the Lie-algebra generated by x and y, is expressed as a commutator series in x and y with coefficients given in terms of certain fixed polynomials. The result is given explicitly to sixth order. Useful recurrence relations are obtained. The method is based on certain properties of higher-order commutator products, particularly their idempotent character. (auth)

41833 C, P, T SYMMETRIES. Lee, T. D. (Columbia Univ., New York). pp 65-89 of Proceedings of the Second Hawaii Topical Conference in Particle Physics, University of Hawaii, Honolulu. Pakvasa, S.; Tuan, S. F. (eds.). Honolulu, Hawaii, University of Hawaii Press, 1968.

See CONF-670841.

A general discussion of C, P, and T symmetries is given including symmetry principles and their violations, time reversal symmetry, the implication of nonconservation, and group extension. Also the possible existence of a C_{π} and T_{π} violating electromagnetic interaction is considered. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstracts 41724, 41725, and 41784.

41834 UNITARITY AND TCP INVARIANCE IN $K^0 \to 2\pi$ DECAY. Kabir, P. K. (Univ. of Cincinnati). Phys. Rev. Lett., 21: 314-16(July 29, 1968).

Unitarity and TCP invariance suffice to predict the as yet unmeasured phase φ_{00} of η_{00}. Quite severe restrictions are placed on the parameters of $K^0 \to 2\pi$ decay and exclude the particular combination favored at present. (auth)

41835 MODEL FOR THE VIOLATION OF CP INVARIANCE. Das, T. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 21: 409-11(Aug. 5, 1968).

An explicit model for CP nonconservation is constructed within the framework of the current-current form of weak interactions, which has $\Delta I = \frac{1}{2}$ for the CP-invariant part of (nonleptonic) H_w with $|\Delta S| = 1$, violates the $\Delta I = \frac{1}{2}$ rule for the CP-nonconserving part, and has no observable effects of T nonconservation in the leptonic decay modes and the electric dipole moment of the neutron. (auth)

41836 WEAK INTERACTIONS EXPERIMENTAL ASPECTS. Fitch, V. L. (Princeton Univ., N. J.). pp 91-161 of Proceedings of the Second Hawaii Topical Conference in Particle Physics, University of Hawaii, Honolulu. Pakvasa, S.; Tuan, S. F. (eds.). Honolulu, Hawaii, University of Hawaii Press, 1968.

See CONF-670841.

A review is given of developments on the experimental aspects of weak interactions which are most directly concerned with CP violation. It is emphasized that the ultimate source of the violation seen in K_2^1 decay can lie outside the framework of weak interactions. Developments since September, 1966, are primarily considered. The phase of η_{+-} from $K_1^1 - K_2^1$ interference, the phase from coherent regeneration, charge asymmetry, the decay of K_2^1 to two neutral pions, specific tests of T-noninvariance, the $\Delta S = \Delta Q$ rule, the mass difference, $\delta = m_1 - m_2$, and coherent regeneration are considered. (J.F.P.)

41837 K-MESONENZERFAELLE UND DIE SYMMETRIE VON WELT UND ANTIWELT. (Meson (K) Decay and the Symmetry of Worlds and Antiworlds). Faissner, Helmut. Sonderdruck aus Jahrbuch 1966. Koeln und Opladen, Ger., Westdeutscher Verlag, 1966. 54p.

The physics of elementary particles has produced its greatest results through the consideration of symmetries. Empirical symmetries have proven especially useful. The development of present theories on meson (K) decay is reviewed historically. One of the first symmetries brought to light by relativistic quantum mechanics was that between particle and antiparticle. The expectation that antimatter would follow the same physical laws as matter was one of the basic laws of theoretical physics under the concept of invariance under charge conjugation. The discovery that weak interactions are charge asymmetrical invalidated this concept. Symmetry was again derived when the coordinate system was reflected simultaneously with the transition from particle to antiparticle. This symmetry between world and reflected antiworld led to the formulation of the K^0 complex. Characteristics of this complex are described in detail. The recently observed decay of long-lived neutral K mesons into 2 pions again places this symmetry principle in question. The most plausible explanations of the decay are however experimentally refuted. Further experiments are in process and these are briefly described. 29 references. (J.S.R.)

Applications (Strong)

Refer also to abstract 41801.

41838 O(5) POLYNOMIAL BASES. Sharp, R. T.; Pieper, S. C. (Univ. of Illinois, Urbana). J. Math. Phys. (N. Y.), 9: 663-7(May 1968).

Polynomial bases are derived for the irreducible representations of the group O(5). The matrix elements of the infinitesimal generators are given. (auth)

41839 IS ISOSPIN INVARIANCE VIOLATED IN πN BACKWARD SCATTERING? Toernqvist, Nils A. (CERN, Geneva). Nucl. Phys., B6: 187-99(1968)

Isospin invariance implies an inequality for πN cross sections. It is pointed out that, if the low-energy charge exchange experiments are taken literally, they seem to show widespread violation of this inequality in πN backward scattering. (auth)

41840 STRUCTURE AND REPRESENTATION OF SYMMETRY GROUPS OF STRONGLY INTERACTING PARTICLES. Wang, P'ei; Ma, Tsung-fu. Ssu Ch'uan Ta Hsueh Hsueh Pao - Tzu Jan K'o Hsueh, No. 1, 53-97(1965). (In Chinese).

A series of theorems is presented showing the connection between systems of roots, systems of weights, and sets of tensors which are irreducible relative to rotations. The connections between the Weyl group and the structure and representations by simple groups are studied in detail. As an example the problem concerning the matrix formalism of the Weyl group (generalized operator of charge symmetry) of the SU_3 group is discussed. (JPRS)

Field Theories

General

41841 SINGULARITIES OF THE SPECIAL THEORY OF RELATIVITY. Kalitsin, Nikola St. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 133-40(1968).

The general principle of physics that there are singularities nowhere in nature is introduced. Every theory which for some given points in space, for some given moments of time, for some determinate velocities etc. foresees singular values of some physical quantities cannot be true in the same singular regions of space, time, velocities etc., and there it must undergo some alterations by which the singularities will be smoothed away. The singularities of the special theory of relativity are considered for this purpose, the previously considered multitemporal theory of relativity according to which the physical world possesses three spacelike and infinitely many timelike coordinates is discussed. In this theory velocities considered as parameters causing an alteration of the metric of the special relativity theory would remove the singularities in the expressions for the mass and the time interval for v = c. The case of the electron mass is illustrated. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 41714 and 41775.

41842 (JINR-E2-3854) INVALIDITY OF TCP-THEOREM FOR INFINITE-COMPONENT FIELDS. Oksak, A. I.; Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 11p. Dep.

Necessary conditions are given for the TCP invariance of a local field with usual energy-momentum spectrum. Examples are constructed of both Fermi- and Bose-local free infinite-component fields which violate these conditions and consequently do not allow a TCP symmetry. (auth)

41843 (JINR-E2-3891) SPECTRAL REPRESENTATION OF THE TWO-POINT FUNCTION FOR INFINITE-COMPONENT FIELDS. Todorov, I. T.; Zaikov, R. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. Dep.

The general form of a Lorentz invariant two-point function is written down in momentum space as an expansion in terms of eigenfunctions of the total spin. It leads naturally to a local expression for finite-component fields, but incorporates nonlocal infinite-component fields. Explicit examples of such fields with increasing mass spectrum are constructed. (auth)

41844 (JINR-P2-3847) DYNAMICAL MOMENTS OF CURRENTS OF COMPOSITE PARTICLES IN QUANTUM FIELD THEORY. Matveev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 22p. (In Russian). Dep.

The problem of finding the local currents of the composite particles is considered in the framework of the relativistically covariant quantum mechanical description. (auth)

41845 (JINR-P2-3900) RELATIVISTICALLY COVARIANT WAVE EQUATIONS FOR N PARTICLES IN THE QUANTUM FIELD THEORY. Matveev, V. A.; Muradyan, R. M.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 20p. (In Russian). Dep.

The relativistically covariant equations for N particles are derived on the basis of the quasi-potential method of the quantum field theory. (auth)

41846 (NP-17547) SOME REMARKS ABOUT TESTS TO PROVE THE VALIDITY OF QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES: MUON AND ELECTRON PAIR PRODUCTION PROCESSES; (G-2)-EXPERIMENT OF THE MUON; ELECTRON AND MUON FORM FACTORS. Report No. 14. Rodenberg, Rudolf (Oklahoma State Univ., Stillwater. Technische Hochschule, Aachen (West Germany). Physikalisches Institut (III)). Apr. 1966. 119p. Dep.

A brief introduction to the present experimental and theoretical situation which is concerned with the tests of quantum electrodynamics (QED) at small distances (SD), performing wide-angle muon and electron pair production processes and by determining the anomalous magnetic moment of the muon, is given. The present disagreement between theory and experiment in the wide-angle muon and electron pair production processes can be roughly removed if one takes into account the influence of strongly interacting channels in the peripheral and diffraction scattering processes. Using that theoretical result and the present experimental kinematical data for the production processes one can say, that there exists no breakdown of QED at SD and that there exists no heavy electron. The only one predictions one can make result in the effect that higher resonance channels in the Compton diagram remove roughly the disagreement between theory and experiment in the correct direction and correct order of magnitude. (auth)

41847 BOUND STATES OF A RELATIVISTIC TWO-BODY SYSTEM. Binder, M.; Razavy, M. (Univ. of Alberta, Edmonton). Nuovo Cim., 56A: 553-7(Aug. 1, 1968).

The bound state of two massive boson fields coupled together by a real scalar field is studied. Using the N-quantum approximation an integral equation for the "wave function" is obtained. The eigenvalues of the resulting equation are compared with the eigenvalues of Schrödinger, Klein-Gordon and Bethe-Salpeter equations. When the binding energy is small compared to the masses of the fields, the coupling constant obtained from this equation is close to those found from Klein-Gordon and Schrödinger equations, but it is smaller than the coupling constant obtained from the Bethe-Salpeter equation. (auth)

41848 CONSTRUCTION OF A QUASIPOTENTIAL IN SOME MODELS OF QUANTUM FIELD THEORY. Desimirov, Georgi. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 155-64(1968). (In Russian).

The general structure of the quasipotential in a model with mutual interaction of two-component spinor fields is considered. The quasipotential is introduced in the sense of previous work. Assuming that the core of the Bethe–Salpeter equation could be expanded in series according to perturbation theory, it is shown, with some restrictions, that a pole term of the bond constant should appear in the quasipotential. The conditions for no contribution of this term are found. (auth)

41849 GAUGE INVARIANCE, BROKEN SYMMETRIES, AND FIELD-CURRENT IDENTITIES. Dass, Tulsi (Indian Inst. of Tech., Kanpur). Phys. Rev. Lett., 21: 242-4(July 22, 1968).

It is shown that (approximate) field-current identities appear in a natural way in a Yang-Mills-type theory if the local symmetry is spontaneously broken. (auth)

41850 SELFCONSISTENT METHOD IN QUANTUM ELECTRODYNAMICS. Yamamoto, Hiroshi (Fukui Univ., Japan). Progr. Theor. Phys. (Kyoto), 39: 1369-70(May 1968).

The idea that the effective coupling constant of a weak interaction remains unchanged by the strong interaction correction is applied to the electromagnetic interaction. An eigenvalue equation for the fine structure constant is obtained which yields the same non-trivial solutions as the eigenvalue equation for the electron mass. A Langrangian of quantum dynamics is proposed which includes only the electron field with nonlocal interaction and no electromagnetic field. (L.B.S.)

41851 CRUCIAL TEST OF A THEORY OF CURRENTS. Callan, C. G. Jr.; Gross, David J. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 21: 311-13(July 29, 1968).

A discussion is given of interpretation and possible crucial tests of a theory in which the energy-momentum tensor is written in terms of currents. (auth)

41852 ANALYTIC STRUCTURE OF ENERGY LEVELS IN A FIELD-THEORY MODEL. Bender, Carl M.; Wu, Tai Tsun (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 21: 406-9(Aug. 5, 1968).

A model of $\lambda\varphi^4$ field theory is considered in which perturbation theory diverges and analytically continue the energy levels into the complex λ plane. Using WKB technique, it is determined that the energy levels have an infinite sequence of branch points (where level crossing occurs) with a limit point $\alpha\lambda = 0$. Thus the origin is not an isolated singularity. The resolvent $(z-H)^{-1}$ has an infinite sequence of poles with a limit point at $\lambda = 0$. (auth)

41853 NONEXISTENCE OF FINITE-ENERGY STATIONARY QUANTUM STATES IN NONLINEAR FIELD THEORIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). J. Math. Phys. (N. Y.), 9: 804-5(May 1968).

A simple proof is given which precludes the existence of any finite-energy stationary quantum-state solution to the Schrödinger equation for a physically interesting Lorentz-covariant self-interacting scalar theory. (auth)

41854 NEW FIELD-THEORY APPROACH TO SINGULAR POTENTIALS. Aly, H. H. (American Univ. of Beirut); Taylor, J. G. J. Math. Phys. (N. Y.), 9: 781-5(May 1968).

An approach similar to the methods of renormalization of the Green's functions equations of quantum field theory is adopted

for the singular potential in the Lippman–Schwinger equation. The close relation between this approach and the one used in field theory gives a method to be applied to nonrenormalizable field theories. The physical implication of this approach is discussed. (auth)

41855 FIELD-THEORETIC FORMULATION OF QUANTUM STATISTICAL MECHANICS. Alexanian, Moorad (Univ. of California, Livermore). J. Math. Phys. (N. Y.), 9: 725-33(May 1968).

The notions of strong convergence of state vectors, introduced by Haag in his formalism of axiomatic quantum field theory, are extended to the case of vectors with an infinite number of particles but finite densities. Some general properties of nonequilibrium distribution functions are derived without the use of power series expansions or any other simplifying assumption. An integral representation is obtained for the distribution functions which makes it possible to discuss their behavior for small and large energies and to obtain some information about the singularities of these functions when continued analytically. (auth)

41856 EXACT SOLUTION OF THE DIRAC–PAULI EQUATION FOR A CLASS OF FIELDS: PRECESSION OF POLARIZATION. Chakrabarti, A. (Centre de Physique Theorique de l'Ecole Polytechnique, Paris). Nuovo Cim., 56A: 604-24(Aug. 1, 1968).

Exact solutions are found, for a restricted class of plane-wave external fields, for the Dirac equation generalized through the addition of an anomalous magnetic moment and an electric dipole moment term. These solutions are used to calculate the corresponding classical equations for the trajectory and the precession of polarization. In fact, the polarization is obtained directly in the integrated form and only subsequently its equation of motion is verified. It is seen to obey exactly the classical BMT equation proposed initially only for homogeneous fields and verified for nonhomogeneous fields only up to an approximation. (auth)

41857 MODIFICATION OF SOLUTIONS IN THE FROISSART MODEL AND MASSLESS SECOND-ORDER POLE. Lukierski, J. (Univ. of Wroclaw). Acta Phys. Pol., 33: 969-80(June 1968).

An operator formalism describing the free massless double pole is introduced. It is shown that the covariant decomposition formula of Froissart, describing the massive double pole, has to be essentially modified. The four-parameter family of operators describing the free massless double pole field in all Poincare frames is introduced. It is shown that all Green functions are independent of the parametrization and invariant with respect to the Poincare group. (auth)

41858 ABSENCE OF INTERACTION IN LIE FIELD THEORIES. Greenberg, O. W. (Univ. of Maryland, College Park). Commun. Math. Phys., 9: 13-17(1968).

It is shown that theories of relativistic Lie fields cannot lead to scattering or reactions, even if an infinite number of Lie fields is present. (auth)

41859 REMARKS ON THE QUANTUM FIELD THEORY IN LATTICE SPACE. II. Ezawa, Hiroshi (Gakushuin Univ., Tokyo). Commun. Math. Phys., 9: 38-52(1968).

A strong-coupling approach to $\lambda\phi^4$-meson theory is considered as formulated in a lattice space which is of simple cubic type having lattice constant a and total volume V. Self-adjointness and regularity of the Hamiltonian are established. The strong-coupling perturbation series are examined for the cases with and without mass renormalization. The series for ground state and one-particle state as well as for their energies are shown to converge when the coupling constant is sufficiently large, say $\lambda - \lambda_c$ (sufficient condition). The bounds λ_c it was found increase with the total volume V and/or the cut-off momentum a^{-1}. Some other features of the strong-coupling perturbation theory are also discussed. (auth)

Gravitation and General Relativity

Refer also to abstracts 41188, 41190, 41249, 41758, 41761, 41791, and 41841.

41860 ON THE EFFECT OF DICKE AND THE MULTITEMPORAL THEORY OF RELATIVITY. Kalitsin, Nikola St. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 17: 141-54(1968).

The previously proposed multitemporal theory of relativity is considered for the Dicke effect in the Einstein general relativity theory. Equations of motion in the space R_{4+2}, the advance of perihelion, and the deflection of light are studied. It is concluded that the multitemporal theory of relativity affects the Einstein deflection at the sun very little and as far as the Einstein deflection cannot be considered as being in full agreement with the observations then the value of the deflection calculated using the multiperipheral theory of relativity does not contradict observation either. Thus the theory makes it possible to explain the remaining 39.6″ arc century of the advance of the perihelion of Mercury after subtracting the 3.4″ due to the oblateness of the sun from the classical 43″. In the first approximation the theory considered leads to Newton's equations of motion, only Kepler's constant undergoes a small variation, the difference being far under the accuracy of observation. The deflection of light at the sun's limb is 1.68″ which slightly differs from the Einstein value of 1.75″. The gravitational redshift of spectral lines is the same as in Einstein's theory. This effect is calculated only by the coefficient before dt^2 in the metric, and this coefficient is the same in both theories in the spherical symmetric case in the considered approximation. (J.F.P.)

41861 FURTHER EXAMPLES OF "MACHIAN" EFFECTS OF ROTATING BODIES IN GENERAL RELATIVITY. Cohen, J. M. (Inst. for Space Studies, New York. Yale Univ., New Haven); Brill, D. R. Nuovo Cim., 56B: 209-19(Aug. 11, 1968).

The exact field equations for the metric of axially symmetric, stationary rotating bodies in general relativity are exhibited. They are applied to calculate, to first order in the angular velocity of rotation (but without restriction to weak gravitational fields), the rotation of the inertial frame induced by an incompressible fluid sphere, and by concentric mass shells. In addition, the effect of the exterior field of rotating bodies on light rays is discussed. The results appear qualitatively to agree with some of Mach's ideas on the origin of inertia. (auth)

41862 CLASSIFICATION OF STATIONARY AXISYMMETRIC GRAVITATIONAL FIELDS. Levy, H. (Univ. of Surrey, London). Nuovo Cim., 56B: 253-63(Aug. 11, 1968).

A gravitational stress tensor is defined for an arbitrary axisymmetric stationary metric, and the stationary solutions of Weyl, Lewis, Papapetrou, Kerr, Marek and Newman, Unti and Tamburino are classified by expressing them in a single canonical co-ordinate system. (auth)

41863 NONNEWTONIAN GRAVITATIONAL FORCES ABOUT AN ELASTIC MASSIVE SPINNING SPHERE. Papini, G.; Cranna, K. G. (Univ. of Saskatchewan, Regina). Nuovo Cim., 56B: 327-33(Aug. 11, 1968).

The field generated by a uniformly rotating elastic massive sphere is determined in general relativity. The method developed by Florides and Synge is used. This method enables one to take into account the relative smallness of mass and angular velocity of the body, its validity is not limited to a region near the spinning object but extends over the whole space, and one starts from the corresponding Newtonian approach. The calculations are carried out to fifth order. No difference exists in the first three steps between the field of an elastic sphere and that of an unspecified rotating sphere in the Lense–Thirring approximation. The structure of the body appears via the elastic constants in fourth and fifth order. Forces other than the Lense–Thirring one, which do not integrate to zero over a closed path, appear in fifth order. The vacuum is set at N = 6. (J.F.P.)

41864 PHASE-SPACE STRUCTURE IN NONLOCAL THEORY. Wataghin, Gleb. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 43: 271-2(Nov. 1967). (In Italian).

Some remarks concerning the general formalism of a nonlocal theory proposed previously and based on a composite model of particles and on an extension of the concept of the phase space are given. The condition of macroscopic causality is discussed. The relation between the quark model and the theory of an interaction between two arbitrary elementary particles is briefly mentioned. (auth)

41865 SPHERICALLY SYMMETRIC SPACE-TIME OF CLASS ONE AND ELECTROMAGNETISM. Pandey, S. N.; Kansal, I. D. (Univ. of Roorkee, India). Proc. Cambridge Phil. Soc., 64: 757-64(July 1968).

It is well known that a spherically symmetric space-time is, in general, of class two. A necessary and sufficient condition for a spherically symmetric space-time to be of class one has, however, been obtained in terms of the Riemann curvature tensor. By means of a transformation property of s.s. space-time three distinct cases are shown to exist. The incompatibility of class one spherically symmetric space-times with Rainich algebraic conditions is established in these three cases. It is concluded that spherically electromagnetic fields cannot be embedded in a flat space of 5-dimensions. (auth)

41866 INELASTIC ALPHA-PARTICLE SCATTERING ON ^{65}Cu AT 29 MeV. Kumabe, Isao; Matoba, Masaru; Takasaki, Eiichi (Kyoto Univ.). J. Phys. Soc. Jap., 25: 301-6(Aug. 1968).

The excited states of ^{65}Cu were studied by inelastic scattering

of 29-MeV alpha particles. The overall energy resolution of about 70 keV in this experiment permitted the resolution of six quadrupole and eight octupole states. Transition strengths were extracted for these states using the DWBA method. The results were compared with the weak-coupling core-excitation model and with the theoretical calculation of Thankappan and True. (auth)

Scattering Theory

Refer also to abstracts 41754, 41830, and 42101.

41867 (LPTHE-TH-68/10) REVIEWS OF THE RELATIVISTIC ASPECTS OF THE THREE-BODY PROBLEM: PRACTICAL COMPUTATIONS FORM FACTORS IN S-MATRIX THEORY. Omnes, R.; Basdevant, J. L. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Mar. 1968. 35p. (CONF-680442-1). Dep.

From International Conference on the Three-Body Problem, Houston, Tex.

A review of the practical approaches to relativistic three-body calculations is given. Some attention is given to the limitations of the relativistic versions of the Faddeev equation and the separable approximation. The practical results obtained with the three-pion system by Basdevant and Kreps are discussed and compared with the experimental data. The ND^{-1} approach to the three-body problem by Mandelstam is reviewed. For illustration and simplicity, the problem of the computation of form factors is given as an example. It is stated, and this is a new result, that the equations are self-contained. This implies that the Frazer-Fulco analysis of isovector form factors can be extended to the isoscalar form factors. Finally one gives the results of a recent extension of the same technique to the N-body problem. The conclusions are negative: linear equations in one variable for form factors do not seem to exist. Some consequences are derived which bear upon the existence, unicity and asymptotic behavior of current form factors. (auth)

41868 SELF-CONSISTENT VACUUM TRAJECTORY. Mickens, R. E. (Vanderbilt Univ., Nashville). Nuovo Cim., 56A: 799-805(Aug. 1, 1968).

The elastic scattering of two equal-mass scalar particles at very high energies is considered. Unitarity relations are used to obtain information concerning the leading Regge trajectory, under the assumption that the scattering amplitudes at high energies are dominated by Regge poles. (L.B.S.)

41869 t-CHANNEL REGGE AMPLITUDE FROM s-CHANNEL RESONANCES. Goebel, C. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev. Lett., 21: 383-4(Aug. 5, 1968).

A counter example is constructed to an alleged theorem that direct-channel resonances lying on rising Regge trajectories cannot asymptotically simulate a crossed-channel Regge amplitude in the direct-channel physical region. The crucial point is that the residue of a Regge pole falls strongly with energy. (auth)

41870 QUASI-LOCAL TERMS IN THE FUNCTIONAL FORMULATION OF THE S-MATRIX THEORY. Hanckowiak, J. (Univ. of Wroclaw). Acta Phys. Pol., 33: 711-22(May 1968).

Quasilocal terms in the functional formulation of the S-matrix theory are investigated. The quasilocal terms that arise in the formulation of Lehmann, Symanzik and Zimmermann and those corresponding to the interaction functionals J[q] that do not contain derivatives, are given. (auth)

41871 ABSORPTIVE CORRECTIONS AND REGGE SINGULARITIES. Finkelstein, J.; Jacob, M. (CERN, Geneva). Nuovo Cim., 56A: 681-93(Aug. 1, 1968).

Two possible alternative methods of computing unitarity corrections to Regge-pole amplitudes are discussed. One method is to correct for rescattering, as motivated directly from the unitarity relation; the other is to correct for absorption, in order to account for the presence of competing channels. It is shown that these two corrections have the same singularity structure, but need not be the same; in the simplest cases the corrections have the same magnitude, but differ in sign. (auth)

41872 ON FUNCTIONAL S-MATRIX THEORY: GENERALIZATION FOR VECTOR FIELD WITH MASS. Morawiecki, K. (Univ. of Wroclaw). Acta Phys. Pol., 33: 733-42(May 1968).

An extension of the functional formulation of the S-matrix theory to the vector field is given. The connection between the existence of the three physical degrees of freedom and the conditions for the off mass shell S-matrix elements is investigated. (auth)

41873 CROSSING RELATIONS FOR HELICITY AMPLITUDES IN PROCESSES WITH n FINAL PARTICLES AND THEIR IMPLICATIONS FOR THE MULTI-REGGE MODEL. Capella, A. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 56A: 701-18(Aug. 1, 1968).

The crossing relations for helicity amplitudes are generalized to processes with n particles in the final state; these relations are obtained under the assumption that the spinor amplitudes are analytic in a domain big enough to allow crossing. The crossing relations turn out to be very similar to those for two-body processes. The consequences of the crossing relations for the multi-Regge model are analyzed, mainly in connection with the factorization principle. Applications are made to the study of decay angular distributions of resonances produced in such processes. (auth)

41874 KINEMATICAL SINGULARITIES OF THE TRANSVERSITY AMPLITUDES. Kotanski, A. (CERN, Geneva. Jagellonian Univ., Krakow). Nuovo Cim., 56A: 737-54(Aug. 1, 1968).

All different mass cases for the two-body processes have been classified and kinematical singularities of the transversity amplitudes have been found, except in the zero-mass cases. It is found that the singularities at the thresholds and pseudothresholds are factorizable while at the boundary of the physical region they are rather complicated, in contrast with the helicity amplitudes. Therefore there are no constraints for transversity at the thresholds and pseudothresholds, while there are constraints at the physical region boundary (i.e., at the forward and backward directions). (auth)

41875 SIGNATURE PROPERTIES IN THE PERTURBATION-THEORY MODEL OF COMPLEX ANGULAR MOMENTUM THEORY. Polkinghorne, J. C. (Cambridge Univ., Eng.). Nuovo Cim., 56A: 755-63(Aug. 1, 1968).

It is shown how to introduce signature into the model of complex angular momentum theory provided by Feynman integrals with spinless particles. The signature, and some other properties of Mandelstam cuts are elucidated. (auth)

41876 OREAR BEHAVIOR IN POTENTIAL SCATTERING. Johnson, Porter (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 9: 712-18(May 1968).

A class of potentials for which the corresponding scattering amplitude f decreases rapidly in energy at fixed (nonforward) angles is found and studied. Specifically, it is required that $f(k, \theta) = O[\exp\{-b(\theta)k\}]$ as $k \to \infty$ for θ fixed. It is shown here that this relation is valid for certain potentials V(r) which are even functions of r analytic in a strip about the real r axis. With further restrictions on the potentials it is shown that the scattering amplitude converges to its first Born approximation at high energies for fixed nonforward angles. (auth)

41877 INTEGRAL EQUATION FOR THE SCATTERING OPERATOR. Wilner, M. (Lowell Technological Inst., Mass.). J. Math. Phys. (N. Y.), 9: 719-24(May 1968).

An integral equation, originally derived for a perturbation expansion of the n-point scattering function (Pugh's equation), whose (finite) solution is the renormalized perturbation result, is derived as an exact "strong" equation for the nth operator derivative of the scattering operator, whose vacuum expectation value is the n-point function. (auth)

41878 LOWER BOUND OF ELASTIC SCATTERING AT A FIXED MOMENTUM TRANSFER. Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 7: 308-11(May 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 391-3(May 20, 1968).

A limit is established on the decrease of the amplitude of elastic scattering $F(s,t)$ as $s \to \infty$ and for fixed $t < 0$. (L.B.S.)

41879 OVERLAP FUNCTION IN MANY-BODY THEORY. Jackiw, R. (CERN, Geneva. Harvard Univ., Cambridge, Mass.). Nucl. Phys., B6: 233-45(1968).

Van Hove's overlap function is studied in many-body Schroedinger theory. A formula relating the overlap function at large impact parameter to the two-body forces is established, within lowest order in these forces. The shape of the diffraction peak as a function of the forces is discussed. The inverse problem of determining the forces from the overlap function is solved. The limiting form of the overlap function for small impact parameters is determined. A simple expression for this limit is obtained when the forces are short range. (auth)

41880 IMPACT PARAMETRISATION AND DAUGHTER TRAJECTORIES. Chang, N. P. (City Coll., New York); Mahanthappa, K. T. Nucl. Phys., B6: 200-4(1968).

Using the impact-parameter representation suggested by a study of kinematics at infinite momentum, the analytic properties of the

direct s-channel partial-wave amplitude are discussed and it is found that a simple b = 0 behavior of the impact-parameter amplitude leads to an infinite number of poles in l-plane. (auth)

Particle Accelerators

Refer also to abstracts 40495, 41885, and 41905.

41881 (AEC-tr-6936) PROGRAM OF PHYSICAL EXPERIMENTS ON A 1000-GeV CYBERNETIC PROTON ACCELERATOR. Dolgosheina, B. A.; Nikitina, Yu. P.; Frolova, V. V. Translation of Programma Fizicheskikh Eksperimentov na Kiberneticheskom Uskoritele Protonov na Energiyu 1000 GeV, Radioteknicheskii Institut, Moscow, Akademiya Nauk SSSR, Moscow, 1967. 232p. Dep. CFSTI.

An abstract was prepared from the original language and was included in NSA as 22: 18066. (TSS)

41882 (CERN-68-25) NONLINEAR STEP-PULSE STEEPENING DELAY LINE. Brueckner, A. (European Organization for Nuclear Research, Geneva (Switzerland)). July 12, 1968. 13p. Dep.

A method for producing a fast rise-time of a step-pulse to be applied to the kicker system between the booster and the CERN Proton Synchroton (PS), where magnetic field rise-times of the order of 45 nsec are required, is described. This steepening time will be used as the tail clipper and will produce a fast fall-time for PS injection. The method described uses a lumped delay-line with linear capacitors and nonlinear inductors. (W.H.K.)

41883 (DESY-68/24) MEASUREMENT OF THE YIELD OF PHOTONS ON THE INTERNAL TARGET OF THE SYNCHROTRON. Raquet, E.; Timm, U. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1968. 27p. (In German). Dep.

The efficiency and other features of bremsstrahlung production on an internal synchrotron target are investigated. Effects of target thickness, energy and collimation are investigated and summarized by a semi-empirical formula. The results show that the photon yield is nearly independent of target thickness. The angular spread, however, depends rather strongly on energy. The target extension has been investigated; one can conclude that point targets can be used without loss of yield. Reduction of angular spread in the photon beam by a scraper is demonstrated. (auth)

41884 (INR-875/SLBAL/PL) BEAM MATCHING BETWEEN 510-keV PROTON INJECTOR AND 10-MeV LINEAR STRONG FOCUSING ACCELERATOR. Dziura, E. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 26p. Dep.

Optical parameters of the beam matching system between a 510-keV proton injector and a 10-MeV linac are determined. Taking into consideration the properties of the optical channel of the linac strong focusing system, two magnetic triplet arrangements allowing precise matching of the source emittance to the acceptance of the linac were chosen. A range of magnetic lens gradients as a function of focal strengths was computed and is illustrated graphically. (auth)

41885 (RHEL/M-124) PROCEEDINGS OF SYMPOSIUM ON SEPARATED ORBIT CYCLOTRONS AND BEAM- CAVITY INTERACTIONS, OXFORD, JULY 1966. Russell, F. M. (ed.) (Rutherford High Energy Lab., Chilton (England)). 288p. (CONF-660725).

Separate abstracts were prepared for the 21 papers presented. (W.H.K.)

For abstracts of individual papers see: 41886–41906.

41886 (RHEL/M-124, pp 1-11) INTENSITY LIMITATIONS IN LINACS AND APPLICATION TO S.O.C. Lapostolle, P. (CERN, Geneva).

A comparison of beam limitations in linear accelerators and separated-orbit cyclotrons is given. Space charge effects and beam loading effects are briefly discussed. (W.H.K.)

41887 (RHEL/M-124, pp 13-27) BEAM-CAVITY INTERACTIONS IN THE S.O.C. Lee-Whiting, G. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.).

The excitation by the proton beam of unwanted electromagnetic fields in a separated-orbit cyclotron cavity and the deflections suffered by the protons of the beam as a result of these fields are discussed. (W.H.K.)

41888 (RHEL/M-124, pp 29-42) STATUS REPORT ON THE ELECTRON ANALOGUE BEAM LOADING EXPERIMENT. Schneider, H. R.; Norbury, J. (Atomic Energy of Canada Ltd., Chalk River, Ont.).

The effects of a 2-A beam current on the cavity fields in the separated-orbit cyclotron being considered for the ING project is being studied using an electron analog. The experimental arrangement consists basically of a pulsed electron source, a scale model of a separated-orbit cyclotron cavity through which the beam passes, an electron energy analyzer, and instrumentation for determining various characteristics of the cavity fields. The present status of the experiment is described. (W.H.K.)

41889 (RHEL/M-124, pp 43-5) INSTABILITIES OBSERVED ON THE ORSAY STORAGE RING ACO. Bruck, H. (Centre d'Etudes Nucleaires, Saclay, France).

A summary of performance characteristics of the Orsay storage ring ACO is given. Noticeable nonlinear resonances, unstable coherent synchrotron oscillations, and vertical and horizontal beam enlargement are briefly described. (W.H.K.)

41890 (RHEL/M-124, pp 47-56) HIGH CURRENT LIMITATIONS. Courant, E. D. (Brookhaven National Lab., Upton, N. Y.).

Transverse instabilities of a particle beam in repetitive and nonrepetitive circular accelerators and in linear accelerators are discussed, and work done on this problem is briefly reviewed. (W.H.K.)

41891 (RHEL/M-124, pp 57-70) EFFECTS OF NON-LINEAR FIELD ERRORS. Worsham, R. E. (Oak Ridge National Lab., Tenn.).

The distortion of the beam shape in phase space and the reduced acceptance of separated-orbit cyclotrons is studied as a function of the deviation of the field index over the aperture. The tolerance of nonlinear field errors is set at a value which produces only a negligible effect on the acceptance and beam quality. Field index values and field deviation at aperture edges are given for a 4-MeV and a 50-MeV separated-orbit cyclotron. Acceptance diagrams as functions of magnetic field shapes are also presented. (W.H.K.)

41892 (RHEL/M-124, pp 71-81) EMITTANCE GROWTH IN THE S.O.C. Billinge, R. (Rutherford High Energy Lab., Chilton, Eng.).

Effects which increase the radial phase space area occupied by an injected beam in low-energy separated-orbit cyclotrons are discussed. (W.H.K.)

41893 (RHEL/M-124, pp 83-100) ALIGNMENT TOLERANCES AND SPACE CHARGE. Chidley, B. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Recent refinements to orbit tracing techniques and estimates of alignment tolerances for a three-stage 1-GeV separated-orbit cyclotron are discussed. Orbit tracing refinements include second order calculations for treating magnet nonlinearities and improved space charge calculations. Magnet alignment tolerances for bench alignment of the pole tips and alignment of the yokes are given. (W.H.K.)

41894 (RHEL/M-124, pp 101-5) TRANSVERSE FORCES IN S.O.C. ACCELERATING CAVITIES. West, N. D. (Rutherford High Energy Lab., Chilton, Eng.).

In a sector shaped cavity the beam will experience transverse forces due to both electric and magnetic rf fields. The magnetic forces arise from the vertical component of magnetic field which exists on the median plane, and the electric force is due to the curvature of the accelerating electric field between the inclined side walls of the cavity. A third source of transverse forces arises from the disturbance of the field distribution in the region of the beam holes cut in the cavity side walls. The net transverse force which deflects the beam is briefly discussed. (W.H.K.)

41895 (RHEL/M-124, pp 109-32) OAK RIDGE 50 MeV S.O.C. DEVELOPMENT PROGRAM. Martin, J. A.; Howell, L. N.; Hudson, E. D.; (and others) (Oak Ridge National Lab., Tenn.).

Topics discussed include beam dynamics, smooth cavity voltage errors, rf cavities and power system, power amplifiers, facility planning, and future plans. (W.H.K.)

41896 (RHEL/M-124, pp 133-44) THE 4-MeV EXPERIMENTAL S.O.C.: A REVIEW. Worsham, R. E.; Hudson, E. D.; Mann, J. E.; Martin, J. A.; McDaniel, F. E.; Mosko, S. W.; Richardson, E. G. Jr.; Ziegler, N. F. (Oak Ridge National Lab., Tenn.).

A description of the 4-MeV ORNL separated-orbit cyclotron is given, and design parameters are listed. Data presented include stability of betatron oscillations, output energy and operating cavity voltage vs harmonic number for protons and deuterons, and cavity voltage required in each cell for exact synchronous operation with harmonic operation. (W.H.K.)

41897 (RHEL/M-124, pp 145-65) SEPARATED ORBIT CYCLOTRON IN THE STUDY FOR THE INTENSE NEUTRON GENERATOR AT CHALK RIVER. Lewis, W. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.).

A reference design for an accelerator to produce a 65-mA, 1-GeV proton beam for the Intense Neutron Generator at Chalk River is presented. The accelerator system consists of a 750-keV preinjector, a 0.75- to 10-MeV linac, and three separated-orbit cyclotron stages of 10 to 50 MeV, 50 to 300 (or 400) MeV, and 300 (or 400) to 1,000 MeV. (W.H.K.)

41898 (RHEL/M-124, pp 167-79) THE S.O.C. BOOSTER FEASIBILITY STUDY. Russell, F. M. (Rutherford High Energy Lab., Chilton, Eng.).

The 70-MeV separated-orbit cyclotron booster feasibility study for the Harwell synchrotron is briefly discussed. Recent modifications and improvements are described. (W.H.K.)

41899 (RHEL/M-124, pp 181-98) MAGNET DEVELOPMENT FOR THE 50-MeV S.O.C. Hudson, E. D.; Lord, R. S.; Mann, J. E.; McDaniel, F. E. (Oak Ridge National Lab., Tenn.).

A full-scale prototype sector magnet for the 50-MeV ORNL separated-orbit cyclotron is described, and results of preliminary tests are presented. Also, specifications for the 50-MeV separated-orbit cyclotron are included. (W.H.K.)

41900 (RHEL/M-124, pp 199-202) BEAM MONITORING AND CONTROL. Coupland, J. H. (Rutherford High Energy Lab., Chilton, Eng.).

A brief description of a beam monitoring and control system proposal for a separated-orbit cyclotron which consists of sensing elements and corrective coils is given. (W.H.K.)

41901 (RHEL/M-124, pp 205-22) EXPERIMENTS AND FIRST RESULTS ON THE 1:1 MODEL OF A H_{101} CAVITY FOR THE ETH CYCLOTRON. Lanz, P. (Eidgengoffische Technische Hochschule, Zurich).

A full scale rectangular H_{101} cavity for the ETH cyclotron was built and tested. The master oscillator, power system, fast mercury relay switch, and automatic tuning servo system are described. Preliminary results show that energy gains of over 1 MeV per turn should be achieved without great difficulties in the four-cavity cyclotron. (W.H.K.)

41902 (RHEL/M-124, pp 225-9) CURRENT STATUS OF THE LOS ALAMOS MESON PHYSICS FACILITY. Hagerman, Donald C. (Los Alamos Scientific Lab., N. Mex.).

Development of the 100- to 800-MeV proton linac for the Los Alamos Meson Physics Facility is briefly outlined. (W.H.K.)

41903 (RHEL/M-124, pp 231-41) LINAC FOR THE ING PROJECT. Schneider, H. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Preliminary design of a 975-MeV linac for the ING project is described. The accelerator consists of an ion source and a 750-keV preaccelerator followed by an Alvarez accelerator operating at 200 MHz which accelerates the beam to 165 MeV. Then a side coupled waveguide structure operating at 800 MHz accelerates the beam to 975 MeV. (W.H.K.)

41904 (RHEL/M-124, pp 243-7) LINAC WORK AT KARLSRUHE. Passow, C. (Kernphysik der Technische Hochschule, Karlsruhe).

Development of a 10-GeV proton superconducting linac at Karlsruhe is briefly described. (W.H.K.)

41905 (RHEL/M-124, pp 249-67) SUPER-S.O.C. Russell, F. M. (Rutherford High Energy Lab., Chilton, Eng.).

A new concept in cyclic particle accelerators in which charged particles are accelerated by interaction with another beam of charged particles within a system of cavities is described. Electromagnetic fields for accelerating particles are produced by deceleration of other charged particles. A description of cavity excitation in a separated-orbit cyclotron using electron beams is given. Also, the possibility of using a separated-orbit cyclotron as an injector for a high-energy accelerator is discussed. (W.H.K.)

41906 (RHEL/M-124, pp 269-84) THE 4-MeV EXPERIMENTAL S.O.C.: DESIGN DETAILS. Hudson, E. D.; Mann, J. E.; Martin, J. A.; McDaniel, F. E.; Mosko, S. W.; Richardson, E. G. Jr.; Worsham, R. E.; Ziegler, N. F. (Oak Ridge National Lab., Tenn.).

Specifications for the ORNL 4-MeV experimental separated-orbit cyclotron are listed and design features including magnet system, rf system, and injection are discussed. (W.H.K.)

41907 (UCRL-18318) MAGNETIC SHIELDS FOR SUPERCONDUCTING BENDING AND QUADRUPOLE MAGNETS. Meuser, Robert B. (California Univ., Berkeley. Lawrence Radiation Lab.). June 24, 1968. Contract W-7405-eng-48. 21p. Dep. CFSTI.

The design of iron shielding for superconducting magnets and its effect on magnet design and performance are discussed. A saddle-shaped winding, circular in cross section, will produce a uniform or quadrupole field. A concentric circular iron shield will reduce the stray field, reduce the stored energy, and reduce the required ampere-turns. If the thickness of the shield is properly distributed, the field distribution in the aperture will be unchanged even though the shield saturates. Unsymmetrical shields may be used where the width must be minimized. The weight of the shield for a bending magnet is nearly independent of its size, while the weight of the shield for a quadrupole magnet decreases with increasing size. The shield has little influence on the mechanical stresses. (auth)

41908 HIGH ENERGY PARTICLE GENERATOR. Nunan, Craig S. (to Varian Associates). U. S. Patent 3,390,293. June 25, 1968. Filed June 30, 1964.

A positron generating and confining apparatus is described. It includes means for generating and accelerating a beam of electrons to substantially relativistic velocity; a target electrode of a material having a high atomic number; means for directing said accelerated beam of electrons onto the target for generating positrons; means defining a high intensitivity short longitudinally magnetic field extending through the target and substantially aligned with the direction of incidence of said beam of electrons for confining the positrons generated in said target and imparting a rotational momentum to said positrons, the magnetic field defining means of a length such that positrons in a desired band of energies rotate through a mean angle of substantially 180°; and means for accelerating the positrons after leaving said magnetic field. (U. S. Pat. Gazette)

41909 ELECTRODE STRUCTURE CYCLOTRON HAVING GROUNDE COUPLING PLATES BETWEEN THE DEE-RINGS. Schnuriger, Jean Claude. (to CSF-Compagnie Generale de Telegraphie Sans Fil). U. S. Patent 3,389,283. June 18, 1968. Priority date Dec. 19, 1963, France.

A cyclotron comprising a pair of sectoral dee electrodes with the sector angle reduced below 180°, separated by grounded electrodes is described. Coupling electrodes, insulated from ground and extending between the surfaces of the dee electrodes and the internal walls of the envelope of the cyclotron are provided with such a shape that the capacitance coupling the electrode to the dee is high with respect to the capacitance coupling the electrode to ground, thereby enhancing the difference between resonant frequencies of the electrical circuit of the cyclotron, when operated in push-push or push-pull mode, respectively. (U. S. Pat. Gazette)

41910 A PIG ION SOURCE OF $(^3He)^{++}$ FOR THE VAN DE GRAAFF ACCELERATOR. Kumamoto, Yoshikazu; Isoya, Akira (Kyushu Univ., Fukuoka). Jap. J. Appl. Phys., 7: 936-8(Aug. 1968).

A PIG type ion source for the Van de Graaff accelerator has been developed for the production of $(^3He)^{++}$ ion. Under good operating conditions, $(^3He)^{++}$ ion current amounts to 3% (about 9 μA) of the $(^3He)^{+}$ ion current. The main emphasis in design is to produce the strong magnetic field in the arc chamber. (auth)

41911 STORAGE RINGS AT CERN. Jones, E. (Stanford Univ., Calif.). Phys. Bull. London, 19: 185-6(June 1968).

The basic considerations of colliding beam systems are briefly discussed, together with practical proposals for achieving such systems. The construction of a small electron storage ring at CERN is briefly described, with which it is possible to study experimentally some of the basic problems of the design and operation of proton storage rings. This storage ring model, under the name of CESAR (CERN Electron Storage and Accumulation Ring), has been used to study problems relevant to the construction of a pair of intersecting storage rings (ISR) for the CERN proton synchrotron. An account is given of some of these studies, together with design studies for the ISR, scheduled to be completed by 1971. (UK)

41912 400 kW SPHERE BEAM DUMP (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1743).

A sphere dump used to dissipate the energy of an electron beam after it has been used in an experimental area is described. The main power absorption and dissipation medium is a water-cooled bed of 1 cm dia Al spheres contained in a 25 cm dia tube. The bed of spheres terminates in a peripherally cooled solid Al cylinder which has a long Cu cylinder attached to it. For a flow rate of 100 gpm, the dump should have an average beam power absorption

capacity of 400 kW for incident beam energies $E_0 \leq 25$ GeV. (For details see TID-4100 Suppl. 46). (F.S.)

41913 5.2° BENDING MAGNET (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE–1745).

A bending magnet is described which is used in bending the "A" beam into the 20 GeV/c spectrometer at the Stanford Linear Accelerator. The magnet aperture gap measures 5.78 by 24 in. with a magnet length of 160 in. and a weight of 50 tons. The magnet is fabricated of low carbon steel and the coil is fabricated of copper. (For details see TID-4100 Suppl. 47). (F.S.)

41914 PULSED ELECTRON ACCELERATOR. Abdullaev, G. B.; Bagramov, R. G.; Iremashvili, D. V.; Leont'ev, N. I.; Salaev, E. Yu. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 3-4, 51-6(1967). (In Russian).

A pulsed electron accelerator used to excite semiconductor lasers by means of an electron beam is described. A block diagram of the experimental system is shown. The generator creates pulses which can be adjusted within the 100 to 250 kV range without any change in pulse shape. The generator drives an electron gun which can be represented as a complex load of R = 25 kohm, C = 50 μμf, and L = 1.4 mh and forms negative, bell-shaped pulses with a duration of 200 nsec (at 0.9 level) and a pulse current of 10 A. A two-electrode gun, which forms a parallel, axially-symmetric electron beam with a microperveance of p = 0.08, was used in the system. A thin magnetic lens is used in focusing the electron beam and adjusting its diameter to 5–10 mm on the specimen tested. To study the performance of the system developed, p-GaSe single crystals were used as test specimens. The specimens had a resistivity of 200 ohm·cm at 300°K, with an equilibrium-carrier concentration of 5×15 cm^{-3}. The single-crystal layers with plane-parallel mirror edges were soldered to the cold conductor of a cryostat and cooled by liquid nitrogen. An electron beam with an energy of 80 keV was directed at the specimen surface at an angle of 45°. A spectrograph was used to break the emission down into a spectrum. Dependence of spectral emission intensity on the pumping current in relative units is shown. With an increase in pumping current, the intensity of lines also increased. (ATD)

41915 THE SIRIUS SYNCHROTRON. Chuchalin, I. P. (Scientific Research Inst. of Nuclear Physics, Electronics, and Automation, Tomsk, USSR). Priorda, No. 2, 50-3(1968). (In Russian).

A general description of the Sirius electron synchrotron at Tomsk is given after a brief introduction to types of heavy and light particle accelerators. Principles of its construction are outlined and the functions of the electromagnet, magnet supply system, the high-frequency system, the vacuum system, injection system, and control systems are sketched; a transverse projection of the magnetic sector is provided. The magnet consists of 4 sectors, each of which has 24 blocks; maximum induction in the steel plates is 16,000 G. The electromagnet has a period of 0.084 sec and maximum current of 5140 A. The vacuum chamber is described; the pumping and forepumping systems give a value of 2×10^{-6} mm Hg. Up to 20 indicators are used for determination of electron current. The electrons can be given energies up to 5.0 MeV before entry to this chamber by use of a microtron. The vacuum resonator system for acceleration is described. (BBB)

41916 PARTICLE ACCELERATION. Rosenblatt, J. London, Methuen, 1968. 191p. 35s.

The subject is treated under the following main headings: Particle accelerators as research instruments; fundamental principles of particle acceleration; static accelerators; linear accelerators; low-energy circular accelerators; high-energy circular accelerators; principle of strong focussing by alternating gradients; the future of particle accelerators. (UK)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 40438, 41287, 41661, 41897, 42095, and 42394.

41917 (CNAEM–51) STRAIGHTFORWARD PERFORMANCE OF RESOLUTION CORRECTION. Cansoy, Cetin; Oergeevren, Yilmaz (Cekmece Nuclear Research Center, Istanbul (Turkey)). Apr. 1968. 32p. Dep.

Two different new methods have been developed for the resolution correction of neutron resonance measurements instead of trial-and-error method. These methods have been applied on the experimental results of the second neutron resonance in ^{149}Sm and of the first neutron resonance in ^{169}Tm as examples. (auth)

41918 (JAERI–1157) PROCEEDINGS OF THE SECOND CONFERENCE ON INELASTIC NEUTRON SCATTERING IN SOLIDS AND LIQUIDS, TOKAI, 1967. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Mar. 1968. 144p. (In Japanese). (CONF-671134–). Dep.

Papers (24) dealing with molecular motion, lattice dynamics, ferro- and antiferroelectric materials, ferro- and antiferromagnetic materials, and liquids are included. (D.C.W.)

41919 (N–68–18541) DETERMINATION OF INTERSECTION OF PARTICLE FLIGHT PATH WITH SURFACE OF HELICAL TUBULAR VOID REGION. Wohl, Millard L.; Bogart, Carl D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 25p. (NASA-TN-D–4435). CFSTI.

A method for determining the intersections of a nuclear particle flight path and the wall of a helical tubular duct is presented. FORTRAN listings of computer subroutines which perform the numerical analysis involved are included. The subroutines are useful in any Monte Carlo transport analysis where complex void configurations of helical or pseudohelical geometry are involved. Their immediate purpose in this work is to serve as geometry subroutines to be used in conjunction with 05-R, a Monte Carlo transport code. (auth) (STAR)

41920 (ORNL-TM-2206) THERMAL-NEUTRON FLUX GENERATION BY HIGH-ENERGY PROTONS. Coleman, Wayne A. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 73p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

A revision of NTC, a Monte Carlo computer code that calculates a description of proton and neutron transport below ~450 MeV, is described. The revision includes an extension of the valid energy range to ~3 GeV and a description of the production and transport of π and μ mesons. The basic code theory employed in NTC has been retained in the revised code NMTC. Calculations were made using NMTC, and the results are compared with experimental thermal-neutron flux measurements to determine the validity of the code. In the experiments, accelerator protons ranging from 0.54 to 2.0 GeV were used to bombard thick targets of Be, Sn, Pb, and depleted U, which were surrounded by a large water tank. The thermal-neutron flux was measured as a function of position in the water moderator. The calculated thermal-neutron-flux distributions using NMTC are in good agreement with the experimental results. (W.H.K.)

41921 NEUTRON GROUPS IN THE SPECTRUM OF A PuF_4 SOURCE. Lehman, Richard L. (Univ. of California, Los Angeles). Contracts AT(04)-1-gen-12; W-7405-eng-48. Phys. Rev., 171: 1311-15(July 20, 1968). (UCLA–12-664).

The neutron spectrum of a 1-kg PuF_4 laboratory neutron source was measured by use of nuclear track emulsion and a differentiation technique. The spectrum consists of a minor peak at 0.91 MeV and a major one at 1.55 MeV. The mean energy was found to be 1.35 MeV and the maximum energy 2.8 MeV. Special analysis of the track distribution revealed peaks at 0.91, 1.26, 1.44, 1.64, 1.8, and 2.1 MeV, and weaker ones at 0.5 and 2.5 MeV. The measured spectrum does not differ in principal features from an analytical spectrum obtained by a graphico-numerical study of published thin-target measurements. The analytical study predicts the effects on $F(\alpha,n)$-source spectra when α emitters of different energy from ^{239}Pu are employed, and permits an interpretation of some previously unexplained observations by Chadwick and Constable. (auth)

41922 SOLUTION OF THE TRANSPORT EQUATION WITH ANISOTROPIC SCATTERING IN SLAB GEOMETRY. Bowden, Robert L.; McCrosson, F. Joseph; Rhodes, Edgar A. (Virginia Polytechnic Inst., Blacksburg). J. Math. Phys. (N. Y.), 9: 753-9 (May 1968).

Some systematics which exist between eigenfunctions and adjoint singular integral equations arising in the solution of the transport equation in slab geometry are illustrated. The transport equation is shown to obey a singular integral equation and its relationship to the eigenfunction expansion-method solution is shown. A new method for solving for the expansion coefficients in the eigenfunction expansion method is illustrated by solving Milne's problem. The role adjoint singular integral equations play in finding appropriate weight functions for use in orthogonality relations between the eigenfunctions of the transport equation is briefly discussed. (auth)

41923 THERMAL-NEUTRON DIFFUSION IN LIGHT AND HEAVY WATER. Parks, P. B.; Pellarin, D. J.; Prochnow, N. H.; Baumann, N. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Sci. Eng., 33: 209-17(1968).

Thermal-neutron diffusion coefficients for H_2O and D_2O were determined from static measurements of the neutron relaxation length in boron-poisoned H_2O and D_2O and pulsed measurements of the neutron die-away in different sized containers of these two moderators. The coefficients derived for H_2O agree well with previously reported coefficients, fairly well with Honeck's calculations, and very well with Dorning's more recent calculations. The diffusion coefficients for D_2O were derived from data in the range of (equivalent) poison concentrations, $\Sigma_a(B) = -0.04$ to $+0.04$/cm. Restricting the data to these limits avoids possible difficulties associated with the approach to the Corngold limits at $\kappa = (\Sigma_t)_{min}$ and $\lambda = (\overline{v\Sigma}_t)_{min}$. The coefficients derived for D_2O indicate no discrepancy between pulsed and static determinations of D_0 for D_2O. (auth)

41924 TOTAL NEUTRON CROSS SECTION OF WATER. Neill, J. M.; Russell, J. L. Jr.; Brown, J. R. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 33: 265-7(1968).

The neutron total cross section of H_2O was measured from 0.0025 to 10 eV using the time-of-flight method. Thermal neutrons were obtained by electron bombardment of a W target that was coupled with a Cd-covered cube of borated polyethylene. The scattering cross section for H_2O was extracted from the data by using the Nelkin model. The measured total cross section was compared with the predictions of several models. $\overline{T}$, two thirds of the average kinetic energy of the bound atom in the H_2O molecule, was also determined from the experimental data; comparisons were made with theoretical predictions. (D.C.W.)

41925 INELASTIC THERMAL-NEUTRON SCATTERING BY LIQUID D_2O. Whittemore, W. L. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. Nucl. Sci. Eng., 33: 195-208(1968). (GA–8285).

The General Atomic Neutron Velocity Selector was used to study the details of neutron scattering in liquid D_2O maintained at 300°K. The scattering into various angular directions between 30 and 120° is studied for incident neutrons with energies ranging up to ~0.65 eV. The energy-transfer cross sections, corrected for plural scattering effects, are evaluated to provide data in regions of large energy and momentum transfers not previously available and not readily accessible to experimenters using a reactor as a source of neutrons. The present results agree satisfactorily with the previous results but indicate that the previous results contain effects due to plural scattering in the sample. The present results also are compared with theory. Although there are some regions of acceptable agreement, other regions of poorer agreement indicate that each of these theoretical treatments may need further attention. (auth)

41926 SLOW NEUTRON SCATTERING FROM WATER. Brugger, R. M. (Idaho Nuclear Corp., Idaho Falls). Nucl. Sci. Eng., 33: 187-94(1968).

Neutrons of 0.05-eV energy were inelastically scattered from samples of water. The experiment was arranged so that a correction could be made for multiple scattering and so that the observed scattering law would be measured at momentum change $\hbar\kappa$ smaller than obtained in previous experiments. From the data, it is concluded that at these low κ values the scattering law at fixed β is proportional to κ as predicted by the McMurry-Russell model but by no other models, discrete transitions are no more distinct at these smaller κ's than at larger κ's contrary to the predictions of the McMurry-Russell model, and multiple scattering is important but not as large as predicted and that experimental corrections for it can be made. (auth)

41927 TIME AND SPACE RELAXATION CONSTANTS OF NEUTRONS IN A PROTON GAS. Williams, M. M. R. (London Univ.). Nucl. Sci. Eng., 33: 262-4(1968).

The space and time eigenvalue problems of the Boltzmann equation are studied using the proton gas model of scattering. The Boltzmann equation is reduced to differential form, permitting the Jeffreys–Wentzel–Kramers–Brillouin (JWKB) method to be used. The accuracy of the JWKB method is assessed. (D.C.W.)

41928 BRAGG CUT-OFF EFFECTS ON NEUTRON WAVE PROPAGATION IN GRAPHITE. Utsuro, Masahiko; Inoue, Kazuhiko; Shibata, Toshikazu (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 298-308(June 1968).

Theoretical and experimental studies concerning the effects of Bragg cut-off on the neutron wave propagation in graphite are presented, as analyzed from the two following factors related to the Bragg cut-off. First, the inordinately long mean free path of cold neutrons of energies below the Bragg cut-off causes in some cases serious problems due to the deep penetration and the strong leakage of the cold neutrons. Secondly, the extremely low collision frequency of about 2,500 rad/sec for the cold neutrons produces a "singular frequency" at a point of even lower frequency, wherein the waves do not decay exponentially in the propagating direction. The peculiar behavior of these cold neutrons severely restricts the conditions of experiment under which one can derive an exact value for the propagation parameter in graphite. In certain cases, however, one can obtain approximate information about wave propagation from experiments conducted beyond these limiting conditions, provided that certain precautions are taken in carrying out the experiment and in interpreting the results. An analysis to explain these phenomena and experiments to reveal the effects in graphite are described. (auth)

41929 APPLICATION OF "HOROWITZ OPERATOR" IN TIME-DEPENDENT NEUTRON THERMALIZATION. Rietschel, Hermann (Univ. Fridericiana, Karlsruhe, Ger.). Nukleonik, 11: 139-43(1968). (In German).

The applicability of a "first model" in time-dependent neutron thermalization is investigated. In contrast to earlier expectations it can be shown, that such a model is able to reproduce the asymptotic time decay of a neutron pulse. The first eigenvalue λ_1 and the thermalization time τ are calculated for several moderators, together with the time-dependent flux. To do this, the flux is evaluated in an orthogonal base, which produces good convergence and can easily be generated. (auth)

41930 NEUTRON SOURCE FOR THE PRODUCTION OF INTENSE AND SHORT NEUTRON PULSES. Schneider-Muntau, H.-J. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Angew. Phys., 25: 122-9(July 1968). (In German).

In a high-voltage low-pressure deuterium discharge, neutron pulses with yields up to 5×10^{12} neutrons/sec of the $D(d,n)^3He$ reaction were produced with half-widths between 30 and 100 nsec. A conception of the ion production and its correlation with the neutron yield are discussed. The heating of the target and the depth of penetration of the deuterons are estimated. (auth)

41931 MEASUREMENT OF THE DECAY OF THERMAL NEUTRONS IN AQUEOUS SOLUTIONS OF THE NON-1/v NEUTRON ABSORBER CADMIUM. Larsson, L. G. (Univ. of Tech., Gothenburg, Sweden); Moeller, E. Nucl. Sci. Eng., 33: 218-24(1968).

Measurements were made of the decay constant of thermal neutrons in water poisoned with boron and with the non-1/v absorber cadmium. An experimental method was used in which proper spatial integration of the neutron flux enables data that are representative of the infinite medium to be accumulated without waiting for the establishment of a fundamental mode distribution. The measurements yield effective absorption cross sections in good agreement with presently adopted values. The change in effective absorption cross section with concentration of the dissolved cadmium $(d\sigma_{eff})/(dN)$ was determined for an infinite medium at 20°C. Two- and three-parameter fits of the decay constant yield $-0.32 \pm 0.09 \times 10^{-17}$ b cm^3 and $-0.47 \pm 0.10 \times 10^{-17}$ b cm^3, respectively, for the coefficient $(d\sigma_{eff})/(dN)$. Earlier published measurements have resulted in two to five times larger values, whereas a published calculated value for Nelkin's model is -0.33×10^{-17} b cm^3. (auth)

41932 ANALYTIC RESONANCE INTEGRAL FORMULAE. Steen, N. M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 33: 260-2(1968).

Analytic expressions are given for the evaluation of the resonance integral for negative energy levels using either the Adler or the Breit–Wigner formalism. In addition, an equation is provided for evaluating the infinite dilution integral component from the skewed term for positive energy levels defined by the Adler formalism. (D.C.W.)

41933 HIGH-DENSITY CORRECTIONS FOR NEUTRON SCATTERING FROM FLUIDS. Feinstein, David Lawrence, Stanford, Calif., Stanford Univ., 1967. 135p.

Thesis.

Some basic elements of scattering theory are reviewed. The differential cross section for scattering of neutrons by a system of identical nuclei with zero spin can be written as a product of two terms, one of which depends only on the properties of the scattering system. This term, "the scattering law," which is the time-space transform of the pair distribution function G, is investigated for gases and liquids. It is shown that the convolution approximation ignores perturbations caused by the test particle for $t > o$. For a dilute gas, a normal-mode expansion of the Boltzmann equation is made to estimate the size of the "collective effects" contribution to the scattering law. It is found that for small energy and momentum transfers the "collective effects" contribution dominates the solution. The hydrodynamic and convolution approximations are compared to experimental results for liquid sodium. The Green and Van Leeuwen–Yip derivations of the Boltzmann equation are generalized to higher densities to give a correction term for the scattering law. The Van Leeuwen–Yip formalism is shown to be the linear analog of the Green formalism. It is proved graphically that the second order density term correctly sums the next-to-dominant terms of the Ursell expansion of the correlation function. By making the binary collision expansion of the three particle operator in the second term of the Van Leeuwen–Yip equation the double binary terms that appear in the iterated Boltzmann equation are cancelled. The two remaining double binary terms are shown to be statistical in nature and to lowest order in density, equal to zero. The terms consisting of three or more binary collision operators are shown to give a non-zero correction to the scattering law. (Disser. Abstr.)

41934 DESCRIPTION OF ANISOTROPIC SCATTERING IN THE DOUBLE P_1 METHOD BY MEANS OF ANISOTROPY FUNCTIONS. Gerstl, S. A. W.; Kofink, W. (Univ., Karlsruhe, Ger.). Nucl. Sci. Eng., 33: 249-51(1968).

An analytic treatment of the scattering integral in the double P_1 method is outlined. The feasibility of the continuation of analytic calculations in the energy-dependent transport theory is demonstrated. (D.C.W.)

41935 PLACZEK-TYPE OSCILLATIONS IN GENERAL NEUTRON SLOWING DOWN. Segev, M.; Yiftah, S. (Israel Atomic Energy Commission, Yavne). Nucl. Sci. Eng., 33: 147-50(1968).

Placzek proved that the collision density of neutrons coming from an energy point source and slowing down by isotropic elastic scattering in an infinite one-isotope nonabsorbing medium oscillates in a certain typical manner. It is proved in this paper that Placzek-type oscillations occur in one-isotope infinite media under the most general elastic scattering law and most general absorption law. In particular, the scattering need not be isotropic nor the absorption small or constant. (auth)

41936 ENERGY-DEPENDENT TRANSPORT THEORY ANALYSIS OF INFINITE MEDIUM NEUTRON WAVE PROPAGATION. Warner, John Hilliard Jr. Los Angeles, Univ. of California, 1967. 248p.

Thesis.

An exact solution of the energy-dependent Boltzmann equation is obtained for the case of a plane oscillating source of neutrons in an infinite moderating medium. Two methods of solution are presented. The solution method receiving the major emphasis involves solving the inhomogeneous Boltzmann equation using a Fourier transform in the spatial variable. Assuming isotropic scattering, the scattering kernel is represented by a degenerate kernal approximation. The flux solutions associated with a one-term kernel is used as a model for an incoherently scattering medium. Both energy-dependent and energy-independent scattering cross sections are considered. Linear anisotropic scattering effects in water are then examined by applying a Radkowsky type of prescription. This is followed by consideration of a simple isotropic scattering kernel to study wave propagation in a coherently scattering medium. Finally, the wave propagation problem is solved assuming the energy dependence of the flux can be represented in terms of an associated Laguerre polynomial expansion. This energy variable treatment is compared with the degenerate kernel approximation. The second method of solution is based on an eigenfunction expansion technique which in turn depends on the theory of generalized analytic functions. The Boltzmann equation with an isotropic one-term degenerate kernel is solved for the general time-dependent case. The eigenfunctions and eigenvalues are determined, full range completeness is proved and the special case of neutron wave propagation in an infinite medium is considered. A pair of discrete and a two-dimensional continuum of complex inverse relaxation lengths are found when an isotropic one-term degenerate kernel is used. This type of

structure occurs for both the total and angular fluxes. The discrete relaxation lengths cease to exist for frequencies beyond some critical value. However, the continuum effects become important at frequencies below this value. Numerical calculations for water that were based on an isotropic scattering assumption led to a critical frequency of 78,000 cps. More terms in the isotropic degenerate kernel expansion can lead to an increased number of discrete relaxation lengths but not to a change in the continuum structure. However, consideration of anisotropic scattering does lead to changes in the continuum structure which might have effects on the critical frequency value. Proper consideration of the elastic scattering cross section discontinuity for coherently scattering media is important in studies of the continuum effects in these media. Numerical calculations for graphite indicate that continuum effects can be important at frequencies as low as 100 cps. Also, the dispersion curve intersects a portion of the continuum at around 350 cps though the critical frequency is about 9400 cps. The experimental consequences of this are discussed. Treatment of the flux energy dependence by a two-term polynomial expansion leads to a continuum represented by two cuts. These cuts approximate the area continuum predicted by the degenerate kernel method and more cuts would be expected as more terms in the polynomial expansion were considered. In addition, the polynomial method does not predict a critical frequency. Similar results are expected from multigroup methods. (Disser. Abstr.)

41937 SOLUTIONS TO THE MONOENERGETIC NEUTRON TRANSPORT PROBLEM IN TWO-REGION SPHERES BY THE METHOD OF SINGULAR INTEGRAL EQUATIONS. Doctor, Ronald David. Los Angeles, Univ. of California, 1967. 172p.
Thesis.

The formalism of Case's normal mode expansion method was used to obtain a set of exact solutions to the Boltzmann transport equation for infinite and finite two region spherical geometries. A stationary, monoenergetic neutron distribution, isotropic scattering in the laboratory system and symmetry about the center of the sphere are assumed. Slab-type equations in terms of a pseudo-distribution function are obtained by application of a suitable transformation to the integral form of the Boltzmann transport equation. In order to apply the transformation, it is necessary to assume equal total cross sections for the two regions. Attempts to remove this restriction were unsuccessful. A solution for the pseudo-distribution function is written in terms of a complete set of orthonormal eigenfunctions. The expansion coefficients are found by application of boundary and symmetry conditions. This leads to singular integral equations which are reduced to Fredholm equations of the second kind in the continuum coefficients. The Fredholm equations can be solved exactly, but not in closed form, by an iterative technique involving the use of a Neumann series. A criticality condition is obtained in the reduction procedure. The scalar fluxes are recovered by inversion of the resulting pseudo fluxes. The iterative technique results in successively higher order and more accurate approximations to the exact solutions. Within the zeroth order approximation three logical sub-levels of approximation are identified. The lowest level contains no continuum terms and leads directly to diffusion theory results. The middle (second) level contains no continuum terms in the critical condition but does include a continuum contribution to the scalar flux. This corresponds to the "thick region" approximation. The highest level exhibits continuum terms in both the critical condition and flux expressions. The zeroth-order (second level) approximation is programmed, and the results are exhibited graphically for the special case in which the inner region is a multiplying region and the outer region is non-multiplying. It is noted however, that the equations are of greater generality in that either or both of the regions can be multiplying. Zeroth-order (level 2) critical radius calculations for bare spheres are in excellent agreement with high order S_n calculations. Results for the critical radii of reflected spheres are presented. It was found that the calculated scalar fluxes are discontinuous at the interface between the two media. There are indications that the discontinuity is due to the relatively low order of approximation used. It is believed that higher order approximations, containing additional continuum terms, would diminish or eliminate the discontinuity. (Disser. Abstr.)

41938 DOUBLE SPHERICAL HARMONICS APPROXIMATION FOR CYLINDRICAL AND SPHERICAL GEOMETRIES. Wang, Chi-chung. Madison, Wis., Univ. of Wisconsin, 1967. 118p.
Thesis.

Due to the limitations of diffusion theory and the slow convergence of the widely used spherical harmonics approximations for physical systems with pronounced discontinuities, it was suggested by Yvon that in such cases it would be reasonable to use different expansions in the forward and backward directions, but he did not extend the method to other than slab geometry. In cylindrical and spherical geometries we encounter a more complicated pathology in the vector flux, and exact expansions which can represent the actual behaviors of the discontinuities in the vector flux are difficult to formulate. However, with rather simple double range expansions, suitable DP_N equations are easy to obtain. The result gives a reasonable representation of the discontinuities of the vector flux. Due to the discontinuities of the vector flux at $\mu = 0$, a term in the transport equation involving a Dirac δ-function is introduced by the leakage operator. The treatment of this term has been controversial in the past. The best way to distribute this term between the forward and backward equations based upon physical arguments is presented. Extensive numerical calculations were made to compare the DP_N approximations with different choices of the distribution of the δ-function to the P_N approximations. The results of these calculations indicated that DP_N approximations with forward δ-function coupling give the best results. As a side product of this investigation a new numerical procedure has been developed, which handles the region near the origin by a series solution of the DP_N equations which is then incorporated with Schmidt's method for other points. (Disser. Abstr.)

41939 DISTRIBUTION OF MODERATED NEUTRONS IN A MEDIUM BOUNDED WITH A SPHERICAL SURFACE. Kozachok, I. A.; Kulik, V. V. (Inst. of Geophysics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 6, 529-33(June 1968). (In Ukrainian).

A distribution is studied of point source neutrons in a homogeneous medium bounded with a spherical surface. A problem on neutron moderation is formulated by means of a partial differential equation that is also valid, unlike an age equation, for media with great hydrogen content. An analytical expression is found for the collision density of neutrons in the medium depending upon the sphere radius. Numerical calculations are made for water by means of which the effect of the boundary on the neutron distribution is analyzed. On the basis of the obtained solution a position of an extrapolated boundary is determined. (auth)

41940 P_N BLACKNESS THEORY IN PLANE GEOMETRY. Congdon, S. P.; Mendelson, M. R. (General Electric Co., Schenectady, N. Y.). Nucl. Sci. Eng., 33: 151-61(1968).

The derivation of blackness boundary conditions is reviewed and generalized into a standard matrix formalism that is valid for any order P_N approximation. It is then shown that for a finite slab effective diffusion and absorption matrices can be found which reproduce blackness boundary conditions at the interfaces. In the continuous or infinitely many mesh point description of the black region, the analysis leads to infinite series expressions for the equivalent matrices, which have been evaluated explicitly by means of the Caley–Hamilton theorem for the case of the P_3 approximation. Equivalent matrices have also been derived for two- and three-mesh-point descriptions of the black region. Numerical calculations for three model problems indicate that P_3 blackness theory is a great improvement over conventional P_3 theory and is roughly equivalent to P_5 theory in the prediction of both the exterior scalar flux and the absorption rate in the black region. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 40366, 41961, and 41962.

41941 ANGULAR DISTRIBUTION OF THE d(p,n)2p REACTION AT 45.5 MeV. Margaziotis, Demetrius J. (Univ. of California, Los Angeles. California State Coll., Los Angeles); Wright, Byron T.; van Oers, W. T. H. Phys. Rev., 171: 1170-8(July 20, 1968).

The differential cross section of the reaction d(p,n)2p was measured at 45.5 MeV. Energy spectra of the neutrons were measured at angles between 5 and 35° at 5° intervals with a resolution of approximately 5½%. The experimental spectra are compared with a calculated cross section using the Born approximation, neglecting the n-p final-state interaction and considering the potential V_{np} to be a δ potential. Good agreement is obtained only at small angles. (auth)

41942 NEUTRINO ABSORPTION BY DEUTERIUM. Ellis, S. D.; Bahcall, J. N. (California Inst. of Tech., Pasadena). Nucl. Phys., A114: 636-40(1968).

The cross section for the reaction $^2H(\nu,e^-)2p$ was calculated as a function of neutrino energy using the effective range method to approximate the required nuclear matrix element. The cross section was averaged over the shape of the neutrino spectra from the decay of ^{15}O and ^8B. The results are $\sigma_{av}(^{15}O) = 1.05 \times 10^{-47}$

cm^2 and $\sigma_{tot}(^8B) = 1.20 \times 10^{-42}$ cm^2. The uncertainty of both values is estimated to be ±10%. (auth)

41943 THE d + D REACTIONS AT DEUTERON ENERGIES BELOW 1 MeV. Goldfarb, L. J. B.; Reed, H. E. (The Univ., Manchester, Eng.). Phys. Lett., 27B: 140-3(June 24, 1968).

The d + D reactions at low energies are reconsidered taking into account the two-deuteron quintet state, waves of higher orbital angular momentum, and differences between proton and neutron emission. Comparison is made with recent experiments involving polarized deuteron beams. (auth)

41944 PHENOMENOLOGICAL POTENTIAL FOR d–d ELASTIC SCATTERING. Itoh, Hidehiko (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1361-3(May 1968).

Angular distributions for the elastic scattering of deuterons by deuterium and ^{4}He at 14.2 MeV were measured, and a phenomenological potential analysis of the data was made. The effective d–d and d–^{4}He potentials were obtained through an optical potential analysis that was made using the IBM 7090 program, ELASTIC SCAT. (D.C.W.)

41945 SCATTERING OF POLARIZED PROTONS FROM ^{3}He. Morrow, Leroy Waggoner. Madison, Wis., Univ. of Wisconsin, 1967. 133p.

Thesis.

The polarized proton beam from the Wisconsin tandem electrostatic accelerator was used to make asymmetry measurements in ^{3}He(p,p)^{3}He. The measurements were made at five energies between 4.00 MeV and 10.77 MeV, for center-of-mass angles between 15 and 156°. The new polarization data were used along with earlier polarization and cross-section measurements of McDonald et al., in a phase shift analysis. The analysis was extended down to 1 MeV, using the polarization data of Drigo et al., and the cross-section measurements of Tombrello et al., and of Famularo et al. Two solutions very similar to the two found earlier by Tombrello were found to fit the data. In addition, a new solution was found which fit the data about as well. When the polarization of the ^{3}He recoils was computed for the three solutions, it was found that the results for the new solution were in fairly good agreement with recent measurements made by Baker et al., using a polarized ^{3}He target. The results for the other two solutions were in poor agreement with these data. Certain similarities between the new solution and the phase shifts of high energy nucleon-nucleon scattering were observed. These similarities are discussed. (Disser. Abstr.)

41946 THE D(d,p)^{3}H REACTION WITH POLARIZED DEUTERONS AT $\bar{E}_d$ = 80 keV. Gueckel, F. A.; Franz, H. W.; Fick, D. (Erlangen-Nuremberg Univ., Ger.). Z. Phys., 214: 321-31(1968). (In German).

The tensor analyzing powers A_{zz}, A_{xx-yy} and A_{xz} of the D(d,p)^{3}H reaction were measured at $\bar{E}_d$ = 80 keV. It is shown that the polarization effects at this energy are of the same magnitude as the deviation of the isotropy when unpolarized deuterons are used to initiate the reaction. (auth)

41947 UNIQUE SET OF PHASE SHIFTS FOR THE SCATTERING OF PROTONS BY HELIUM. Plummer, D. J. (Queen Mary Coll., London); Hodges, T. A.; Ramavataram, K.; Montague, D. G.; Chant, N. S. Nucl. Phys., A115: 253-64(1968).

The polarization in the elastic scattering of 10-MeV protons from ^{4}He was measured between 109.5° and 118.5° lab in steps of 1.5°. A phase-shift analysis is presented which leads to a unique set of phase shifts after a thorough search using random starting values. Accurate differential cross sections and polarizations were calculated using this phase-shift solution which should facilitate accurate proton polarization determinations at 10 MeV using helium analyzers. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 40366, 41825, 41980, 42008, 42019, 42126, 42131, 42133, and 42140.

41948 (BNL-tr-218) DIRECT AND INVERSE PHOTONUCLEAR REACTIONS ON ^{15}N AND ^{15}O NUCLEI. Zhusupov, M. A.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P4-3674. 20p. Dep. CFSTI.

Direct and inverse photonuclear reactions on ^{15}N and ^{15}O mirror nuclei are considered in terms of a particle-hole approach with due regard for the pairing correlations of nucleons in the nucleus. A wide peak of the dipole transitions (in the energy range of 20 to 21 and 25 to 26 MeV), as well as a "pigmy resonance" in the energy range of 20 MeV, is given. The isospin structure of the resonance is studied. The "pigmy resonance" is due to the excitation of the states with T = $^1/_2$, while the main peak is due to the states with T = $^3/_2$. The decay mode of the dipole states of the ^{15}N nucleus is calculated. It is shown that the contribution of the three-particle decay channel is rather large. The inverse ^{14}N(p,γ)^{15}O and ^{14}C(p,γ)^{15}N reactions emitting γ-quanta to the ground and excited state I = $^3/_2^-$ of the ^{15}N and ^{15}O nuclei are investigated. The resonances have different structure in these mirror nuclei. (auth)

41949 (ISS-67/44) PROGRESS REPORT OF THE SANITA SUBGROUP OF THE INFN, ANNUAL, 1967. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Dec. 11, 1967. 21p. (In Italian). Dep.

The activities of the "Sottosezione Sanità" of the INFN during the year 1967 are outlined. Research in the fields of elementary particle physics, nuclear physics, solid-state physics, and electromagnetic interactions is described. A brief account of the activities of the theoretical group and of the computing center is also given. (auth)

41950 (ISS-68/8) PRELIMINARY MEASUREMENT OF THE NUCLEAR REACTION ^{12}C(γ,2p)^{10}Be. Capitani, G. P. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Mar. 8, 1968. 34p. (In Italian). Dep.

Preliminary measurements of the cross section of the reaction ^{12}C(γ,2p)^{10}Be are given. The results of the measurements are in disagreement with preliminary measurements of Weinstein et al. The existence of this disagreement, together with more fundamental theoretical reasons discussed in the first part of this report, point to the necessity of further experimentation. (auth)

41951 (ISS-68/10) SHORT RANGE DYNAMICAL CORRELATIONS IN ^{6}Li AND ^{16}O NUCLEI FROM ELASTIC ELECTRON SCATTERING. Ciofi degli Atti, C. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Mar. 30, 1968. 11p. Dep.

The effect of two-body correlations on the electron elastic form factor was considered for ^{6}Li and ^{16}O nuclei. (auth)

41952 (ORNL–4274) DIFFERENTIAL CROSS SECTIONS FOR THE CHARGED PARTICLES PRODUCED BY 60-MeV PROTONS ON CARBON, IRON, AND BISMUTH. Bertrand, F. E.; Peelle, R. W.; Love, T. A.; Hill, N. W.; Burrus, W. R. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 280p. Dep. CFSTI.

Thesis. Submitted by F. E. Bertrand to Louisiana State Univ., Baton Rouge.

The differential cross sections for the production of protons, deuterons, tritons, ^{3}He, and alpha particles by 60-MeV proton bombardment of ^{12}C, ^{54}Fe, and ^{209}Bi were measured over a secondary energy range from 1 to 60 MeV. The particles were detected in an all-solid state, 3-detector, total absorption counter telescope. The system resolution was ~150 keV (FWHM). Secondary charged particles were identified by both ΔE versus E and flight time versus E methods. Protons, deuterons, tritons, ^{3}He, and alpha particles were unambiguously identified over an energy range from 1 to 60 MeV. Data were obtained at 15 to 20 angles between 12 and 160°. The high-energy region of each charged particle spectrum is dominated by elastic scattering and excitation of discrete nuclear levels, and differential cross sections are presented for 37 of the levels observed. The secondary proton spectra from ^{12}C, ^{54}Fe, and ^{209}Bi, below the region of discrete peaks, exhibit a structureless and nearly flat continuum region which at low energies merges into a peaked, nearly isotropic distribution except in the case of bismuth. The spectra of other secondaries have roughly the same continuum shape as the protons except that only the secondary alpha particles show a strong evaporation peak. The magnitude of the energy-integrated differential cross sections for each particle type is strongly forward peaked and decreases rapidly with increasing angle until a constant magnitude is reached for angles greater than ~120 degrees. The ratio of protons to deuterons is ~10 to 20:1 and the ratio of protons to tritons is ~100 to 300:1. The elastic differential cross sections are found to agree with optical model calculations. The proton continuum spectra are compared with estimates from a Monte Carlo intranuclear-cascade plus evaporation calculation. The observed proton cross sections are larger than the estimates for angles larger than ~70° and for angles smaller than ~20°; however, between 20 and 70°, the agreement is within ±30%. More high energy cross section is measured at back angles than is predicted. Especially for the heavier targets, evaporation calculations do not provide enough high energy cross section for deuterons, tritons, ^{3}He, or alpha particles, even at the largest angles of observation. The continuum proton spectra from the

neighboring nuclides ^{54}Fe and ^{56}Fe are found to have equal shapes and cross sections in the energy region above 20 MeV, but ^{56}Fe exhibits a peaked low-energy distribution which is only ~70% as intense as the ^{54}Fe distribution. (auth)

41953 COMPARISON OF CALCULATED RADIOCHEMICAL CROSS SECTIONS WITH EXPERIMENTAL RESULTS FOR INCIDENT PROTONS AND π^- MESONS IN THE 50- TO 400-MeV REGION: EFFECT OF VARYING A FEW NUCLEAR PARAMETERS IN THE CALCULATIONS. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). Phys. Rev., 171: 1261-6(July 20, 1968).

Comparisons are made between theoretical predictions and experimental data for several (p,xpyn) reactions involving C, Al, Cu, and U and for the (π^-,π^-n) reaction in carbon. Interaction energies range from about 50 to 400 MeV. The theoretical model employs the two-step cascade-evaporation mechanism and includes the effect of the diffuse nuclear surface. The comparisons for the proton-initiated reactions indicate that agreement to within about 40% can be expected when the reaction cross section is about 100 mb, but the values can differ by factors of 5 or more when the cross section is about 10 mb. The agreement for the (π^-,π^-n) reaction on carbon was fair. This reaction can be used for the measurement of the real part of the optical-model potential, and the method for doing so is described. The effects of the diffuse nuclear surface in conjunction with changes in the nuclear radius on the (p,pn) reaction are discussed. Finally, results are given for the dependence of the (p,xpyn) cross sections on the transition energy used in the calculation between the cascade and evaporation processes. (auth)

41954 INVESTIGATION OF THE ^{9}Be(^{3}He,n)^{11}C REACTION IN THE ENERGY RANGE 3.5 TO 10 MeV. Okano, K.; Kikuchi, S.; Nishimura, K.; Harada, K. (Japan Atomic Energy Research Inst., Tokyo). Nucl. Phys., A115: 17-32(1968).

The excitation functions and angular distributions of neutrons from the ^{9}Be(^{3}He,n)^{11}C reaction leading to the ground and first excited states of ^{11}C were measured in the energy range 3.49 to 9.96 MeV. The behavior of the excitation curves and the oscillatory pattern of angular distributions indicate that a direct interaction process is predominant in the ^{9}Be(^{3}He,n)^{11}C reaction especially at the incident energies above 5 MeV. The angular distributions obtained at several bombarding energies were compared with the results of DWBA calculations based on a two-nucleon stripping process, and good agreement is obtained for the data taken at 9.93 MeV. The agreement is not satisfactory at lower incident energy region, where the reaction process seems to be more complex. The neutron group leading to the first excited state of ^{11}C shows a L = 2 pattern in higher energy region in contrast with the L = 0 pattern of the proton group observed in the mirror reaction ^{9}Be(^{3}He,p)^{11}B. This is consistent with a selection rule for the di-proton stripping reaction and indicates that the two-nucleon stripping process is predominant in the ^{9}Be-^{3}He reaction. (auth)

41955 SEARCH FOR TRINEUTRONS. Fujikawa, K.; Morinaga, H. (Tokyo Univ.). Nucl. Phys., A115: 1-13(1968).

A search for bound trineutrons in the reaction ^{7}Li(n,^{3}n)^{5}Li was made with neutrons produced by a 55-MeV proton beam incident on a thick metallic lithium target. The detection of the trineutron was attempted with the reaction ^{138}Ba(^{3}n,n)^{140}Ba, whose yield of ^{140}La, the β-decay product of ^{140}Ba, was measured with a low-background counting apparatus. No evidence for the existence of the bound tri-neutron was found within the limits of experimental error. The upper limit was determined at 1 mb for the total cross section of the reaction ^{7}Li(n,^{3}n)^{5}Li at the neutron energies $E_n \approx 14$ to 19 MeV, where its values were expected to become the highest. (auth)

41956 MEASUREMENT OF THE ABSOLUTE TOTAL CROSS SECTION FOR THE REACTION ^{19}F(p,n)^{19}Ne. Riffle, F. L.; Goss, J. D.; Parsignault, D. R.; Harris, J. C. (Ohio State Univ., Columbus). Nucl. Phys., A115: 120-8(1968).

The absolute total cross section for neutron emission in the reaction ^{19}F(p,n)^{19}Ne was measured to better than 10% precision as a function of proton energy, from threshold at 4.234 to 6.01 MeV, in 10-keV intervals. An activation technique involving the measurement of the residual radioactivity of the 17.36 ± 0.06 sec half-life of ^{19}Ne was used. Beam current fluctuations were handled by an adaptation of a leaky integrator technique which allowed continuous accumulation of data. This technique is easily adaptable to radioactive decays with half-lives down to ≈0.1 sec. (auth)

41957 THE ^{19}F(^{3}He,^{6}Li)^{16}O REACTION. Mead, R. O.; Young, F. C. (Univ. of Maryland, College Park). Nucl. Phys., A115: 161-71(1968).

The reaction ^{19}F(^{3}He,^{6}Li)^{16}O (Q = 4.092 MeV) was studied for bombarding energies from 2.0 to 6.0 MeV. Yield curves were measured at 50 and 90°, and the angular distribution was measured at 5 MeV. The lack of resonance structure in the yield curves and the diffraction-like nature of the angular distribution suggest that the reaction is predominately a direct process. A zero-range DWBA calculation was carried out for the differential cross section assuming a triton pick-up process. Calculations were also performed for the ^{11}B(^{3}He,^{6}Li)^{8}Be reaction which had been studied previously. From the ratio of the measured to the calculated cross section for the ^{19}F(^{3}He,^{6}Li)^{16}O reaction and the corresponding ratio for the ^{11}B(^{3}He,^{6}Li)^{8}Be reaction, a relative spectroscopic factor (core plus triton-cluster parentage) was obtained. (auth)

41958 E2 AND M1 MATRIX ELEMENTS IN ^{10}B. Warburton, E. K.; Olness, J. W.; Bloom, S. D.; Poletti, A. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 171: 1178-87(July 20, 1968). (BNL-12121).

Gamma decay of the ^{10}B 2.15- and 3.59-MeV levels was studied following population via the ^{11}B(^{3}He,α)^{10}B reaction at $E_{He^3} = 2.6$ MeV. The γ rays were detected in coincidence with α particles observed in an axially symmetric silicon detector centered at 180° to the beam. γ-ray branching ratios were extracted for both levels. From the angular distributions of the decay γ rays, results were obtained for the E2/M1 mixing ratios x of the decay of the 2^+ 3.59-MeV level to the 3^+ ground state, the 1^+ 0.72-MeV level, and the 1^+ 2.15-MeV level, respectively, as follows: $+0.31 < x < +2.1$, $x^{-1} = +(0.11 \pm 0.10)$, $x = -(0.38 \pm 0.009)$, all pertaining to $\Delta T = 0$ transitions. For the decay of the 2.15-MeV level to the 0.72-MeV level, $x = -(0.29 \pm 0.05)$ or $-(3.39 \pm 0.55)$. Combining these results with previous work gives information on the magnitudes as well as the relative phases of the M1 and E2 matrix elements considered. These results are compared with the predictions of the independent-particle model. (auth)

41959 ELASTIC SCATTERING OF 1- TO 2.7-MeV PROTONS BY ^{14}C. Harris, W. R.; Armstrong, J. C. (Univ. of Maryland, College Park). Phys. Rev., 171: 1230-41(July 20, 1968).

The differential elastic scattering cross section for protons scattered by ^{14}C was measured for energies from 1.0 to 2.7-MeV at cms scattering angles of 39.2, 54.7, 90, 125.3, and 161.4°. Thin self-supporting carbon foils enriched to 10% ^{14}C were used as targets. Outgoing protons were analyzed with a 180° double-focusing magnetic spectrometer at the lower angles, while a solid-state detector was used at 161.4°. The experimental data were fitted using a theoretical expression derived from R-matrix theory and accurate in the "two-level" approximation. Anomalies corresponding to ^{15}N levels at 11.293, 11.416, 11.582, 12.093, 12.144, and 12.524 MeV were observed. Best-fit parameters (center-of-mass proton partial width in keV, cms total width in keV, and J^π) for these anomalies in the order listed are: 5.6, 7.9, $\frac{1}{2}^-$; 11.0, 34.0, $\frac{1}{2}^+$; 415.0, 418.0, $\frac{1}{2}^+$; 1.7, 14.0, $\frac{5}{2}^+$; 16.6, 47.0, $\frac{5}{2}^-$; 80.0, 80.0, $\frac{5}{2}^+$. Although these widths are lower than those previously reported, they are in essential agreement with published data. Uncertainty concerning certain previous J^π assignments has been removed. (auth)

41960 ANALYSIS OF THE ΛΛ HYPERNUCLEUS $_{\Lambda\Lambda}$C^{14}. Ali, S.; Kok, L. P.; Grypeos, M. E. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 171: 1203-7(July 20, 1968).

An analysis was made of the yet unobserved $_{\Lambda\Lambda}$C^{14} system in a Λ-Λ-^{12}C model, using Λ-Λ interactions quite reliably determined from the analysis of $_{\Lambda\Lambda}$He^{6}. Allowance was made for distortion of the core by the two Λ particles. The sensitivity of the results for $\Delta B_{\Lambda\Lambda} = B_{\Lambda\Lambda} - 2B_\Lambda$ to the nuclear compressibility coefficient is explored and the role of the ΛΛ hypernucleus as a possible probe into this coefficient is discussed. Finally, the importance of an accurate experimental determination of $B_{\Lambda\Lambda}(_{\Lambda\Lambda}C^{14})$ was stressed. (auth)

41961 0^+ STATES OF ^{8}Be. Barker, F. C.; Hay, H. J.; Treacy, P. B. (Australian National Univ., Canberra). Aust. J. Phys., 21: 239-57(June 1968).

The light even nuclei with A ≥ 10 have 0^+ excited states near 6 MeV, probably with large α-particle reduced widths. A similar state in ^{8}Be would be very broad. Evidence for 0^+ excited states in ^{8}Be has been obtained using many-level R-matrix fits to known α-α scattering data, but the excitation energies depend strongly on the assumed channel radius. For a simultaneous fit to the ^{9}Be(p,d)^{8}Be cross section, assuming these higher states are not strongly populated, the channel radius is restricted to 7 fm, implying a 0^+ excited state at 6 ± 3 MeV of width 9 ± 4 MeV. (auth)

41962 GIANT RESONANCES IN CLOSED-SHELL NUCLEI WITH REALISTIC NUCLEAR FORCES. Barrett, Bruce Richard. Stanford, Calif., Stanford Univ., 1967. 197p.

Thesis.

The giant resonances of closed-shell nuclei are investigated by

performing as accurate a calculation as possible with the free nucleon-nucleon force and then comparing the results with experiment. To aid in this study, the particle-hole Green's function and the linearization method for analyzing particle-hole excitations and the Wigner SU(4) supermultiplet theory for classifying and describing the giant resonances were used. Using the particle-hole Green's function, higher-order corrections to the Tamm-Dancoff and Random Phase Approximation equations were determined. In particular, it is found that the second-order corrections to the Tamm-Dancoff equations consist of replacing the potential by the t-matrix and of adding a core-polarization term. There is also a correction to the interaction connected with the particle-hole ladder term, if the configuration space used in the calculation is truncated. For L = 1, the identity representation with T = S = 0 is ignored, since it is connected with the spurious excited state arising from the excitation of the center of mass. The rest of the spectrum is then treated as being made up of non-mixing [15] supermultiplets and observe that the splittings within the L = 1 supermultiplets can be expressed in terms of only five parameters, while there are eight pieces of experimental data regarding each supermultiplet. Therefore, the theoretical equations for these splittings are overdetermined, and sum rules which are independent of the form of the nucleon-nucleon potential and enables one to check the consistency of the calculation with experiment and to make empirical predictions of unobserved experimental quantities are determined. The sum rules for ^{4}He predict the location of two states which have since been found to be in agreement with experiment. Sum rule predictions are also obtained for ^{16}O, but so far no experimental data are available for comparison. The negative-parity spectra of ^{4}He and ^{16}O in the Tamm-Dancoff approximation using the separable Tabakin potential and the hard-core potentials of Brueckner, Gammel and Thaler and Hamada. The results for ^{4}He are in reasonable agreement with experiment, even though the p-state contributions are overestimated. The results for the L = 1 supermultiplet states of ^{16}O also agree fairly well with experiment. Therefore, one can conclude that meaningful calculations of nuclear spectra can be made using the free nucleon-nucleon potential. One of the more interesting results is that the single-particle spin-orbit splittings in ^{4}He and ^{16}O can be understood in terms of only the two-particle spin-orbit force. Calculations with realistic forces enable one to determine the E1 transition ratios and the muon capture matrix elements and rates for ^{4}He and ^{16}O. The muon capture results indicate that SU(4) is a good symmetry for these nuclei, since the squared matrix elements calculated with spin-and-isospin dependent forces are found to be equal within 5 percent for ^{4}He and 13 percent for ^{16}O. The result for ^{4}He leads to a definite discrepancy between theory and experiment regarding the total muon capture rate. The relatively small splittings among the states of the [15] supermultiplets in comparison with their centers of gravity also indicate that the SU(4) symmetry in ^{4}He and ^{16}O is not badly broken in the presence of realistic forces. Finally, our muon capture results for ^{16}O imply that the different [15] supermultiplets do not strongly mix and that the two-body spin-orbit force does not affect the magnitude of the squared matrix elements. (Disser. Abstr.)

41963 INELASTIC ELECTRON SCATTERING FROM THE GIANT RESONANCE IN ^{12}C. Ricco, G.; Caplan, H. S.; Hutcheon, R. M.; Malvano, R. (Saskatchewan Accelerator Lab., Saskatoon, Can.). Nucl. Phys., A114: 685-96(1968).

The cross section for the inelastic scattering of electrons from ^{12}C was measured at excitation energies between 20 and 35 MeV and momentum transfers between 0.5 and 0.8 fm^{-1}. The spectra show levels previously observed using photons, but the strengths of these levels are difficult to extract due to the presence of an underlying continuum. However, some idea of the variation of the strengths with momentum transfer could be obtained, and these are compared with the predictions of the collective model of the giant resonance. The underlying continuum is of interest in itself and its magnitude and momentum transfer dependence were investigated. (auth)

41964 A STUDY OF THE ^{6}Li(p,n)^{6}Be REACTION. Wakefield, B.; Macefield, B. E. F. (Oxford Univ.). Nucl. Phys., A114: 561-76(1968).

Angular distributions for the ground-state neutrons were measured at 8.3, 9.0, 9.6, 10.0, 10.5, 15.0, 16.55 and 18.0 MeV using a time-of-flight spectrometer. The excitation and width of the first excitated state of ^{6}Be was measured to be 1.67 ± 0.05 MeV and 1.18 ± 0.07 MeV, respectively. The angular distributions of the neutrons from the 1.67 MeV state were also measured. Below 11 MeV, the angular distributions are simple and indicate a compound nucleus process. Above 11 MeV, the results can not easily be interpreted in terms of the compound nucleus, but on the other hand a direct-reaction theory has also failed to give agreement with experiment. Evidence was found for a possible second excited state in ^{6}Be at about 3.0 MeV. (auth)

41965 REACTION ^{6}Li(π^+,pp)^{4}He AND T = 1 STATES IN ^{4}He. Burman, R. L.; Nordberg, M. E. Jr. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 21: 229-32(July 22, 1968).

An analysis of the reaction ^{6}Li(π^+,pp)^{4}He shows that the mechanism for transitions to the ground and excited states in ^{4}He is dominated by a single-pole model when the momentum transfer is restricted to small values. Preferential excitation of the T = 1 levels in ^{4}He is observed and is explained on the basis of the single-pole model. (auth)

41966 USE OF REALISTIC INTERACTIONS IN NUCLEAR SHELL-MODEL CALCULATIONS INCLUDING CORE EXCITATION. Clement, David Manion. Pittsburgh, Univ. of Pittsburgh, 1967. 149p.

Thesis.

A shell-model calculation of ^{18}F and ^{18}O is performed in which the Tabakin interaction is used as the residual shell-model interaction. Two kinds of second-order corrections are included by perturbation theory. In one, the second-Born corrections, plane-wave intermediate states are used; in the other, particle-hole core excited states are included. The results agree quite well with experiment. A detailed comparison is made between the results of this calculation and that made by Kuo and Brown with the Hamada–Johnston hard-core potential. The matrix elements of the two potentials agree surprisingly well. The second-Born corrections are important in improving the agreement between the two sets of T = 0 matrix elements. A BCS calculation of the even tin isotopes is performed with the Tabakin interaction as the residual interaction. The quasi-particle interaction is treated using the Tamm–Dancoff Approximation (TDA). Only two-quasiparticle (2QP) states are considered. These are of two kinds: 2QP neutron states constructed from twelve filling levels, and proton one-hole-one-particle core excited states. Single-particle energies are taken from experiment or by comparison with Nilsson levels. The changes in the single-particle proton energies as a function of neutron number agree very well with experiment. The first excited 2^+ and 3^- levels also agree well with experiment. (Diss. Abstr.)

41967 GAMMA-RAY TRANSITIONS INVOLVING ISOBARIC-SPIN MIXED STATES IN ^{8}Be. Sweeney, William Earl Jr. College Park, Md., Univ. of Maryland, 1967. 173p.

Thesis.

Laboratory differential cross sections were measured for the reaction ^{7}Li(p,γ)^{*8}Be (16.63 and 16.90 MeV) → 2α over the range of energies from 0.441 to 2.45 MeV. The measurements were obtained by momentum analyzing the breakup alpha particles with a 180° magnetic spectrometer and detecting the particles at the exit of the spectrometer with a position sensitive detector. The 16.63-MeV level was populated at all proton energies from 0.441 to 2.45 MeV. The measured differential cross sections for this non-resonant reaction were compared successfully with calculated cross sections assuming an extranuclear direct reaction process. Resonant cross sections to the 16.63- and 16.90-MeV levels of ^{8}Be were measured at incident energies of 0.441, 1.03, and 1.89 MeV, corresponding to the 17.64-, 18.15-, and 18.9-MeV levels in ^{8}Be. Partial widths and reduced matrix elements were calculated for the resonant contributions to the cross sections. Gamma-alpha angular correlations were measured at 1.50 MeV and at the 0.441-MeV resonance. An expression for the gamma-alpha correlation following a direct capture radiative transition was developed and compared with the experimentally measured correlation at 1.50 MeV. The angular correlation at the 0.441-MeV resonance was used to determine the E2/M1 mixing ratio in the 17.64-16.63 gamma-ray transition. The transition was found to be approximately 0.02% electric quadrupole in intensity. The experimental results are consistent with the hypothesis of nearly maximal isobaric-spin mixing in the $J^\pi = 2^+$ levels of ^{8}Be (i.e., 16.63 and 16.90 MeV), and can be used to more accurately determine the extent of isobaric-spin mixing in the 1^+ levels of ^{8}Be (i.e., 17.64 and 18.15 MeV). (Disser. Abstr.)

41968 REACTIONS ^{12}C(^{3}He,^{3}He)^{12}C AND ^{12}C(^{3}He,d)^{13}N, 12 TO 19 MeV. Fortune, Herman Terry. Tallahassee, Florida State Univ., 1967. 160p.

Thesis.

Yield curves for the elastic scattering of ^{3}He by ^{12}C were measured in 10° intervals from 15 to 175° (lab) over the bombarding energy range 12.0 to 18.6 MeV. Inelastic scattering yield curves were measured at selected angles for the same energy range. Detailed angular distributions for both elastic and inelastic scattering were measured at 16, 17 and 18 MeV. The elastic scattering was analyzed with the optical model. For the reaction ^{12}C(^{3}He,d)^{13}N, excitation functions from 12.0 to 18.6 MeV and detailed angular distributions at 16, 17 and 18 MeV were measured

for deuterons leading to the ground state and first three excited states of ^{13}N. At 19 MeV, angular distributions of deuterons leading to the first seven excited states of ^{13}N were measured. The ground state reaction $^{12}C(^3He,d_0)^{13}N$ was analyzed with the conventional distorted-wave Born approximation. A variety of calculations were attempted, with some success, for stripping to the excited states, all of which are unbound with respect to proton decay. (Disser. Abstr.)

41969 REACTION $^{12}C(^3He,\alpha)^{11}C$, 12 TO 18 MeV. Gray, Thomas Jack. Tallahassee, Florida State Univ., 1967. 138p.
Thesis.
Yield curves for the reactions $^{12}C(^3He,\alpha)^{11}C$ leading to the ground state and the first and third excited states of ^{11}C were measured at selected angles over a ^3He energy of 12.0 to 18.0 MeV. Detailed angular distributions for the alpha particle groups leaving ^{11}C in its ground state and first six excited states were measured at bombarding energies of 16, 17, and 18 MeV. Angular distributions for alpha particle groups leaving ^{11}C in its seventh through eleventh excited states at a bombarding energy of 18 MeV are reported. By assuming a configuration mixed ground state for ^{12}C, DWBA pickup calculations were performed for the angular distributions leading to the ground state and first nine states of ^{11}C. Relative spectroscopic factors for the various alpha transitions are reported and are compared to the results of others for $^{12}C(p,d)^{11}C$ reactions which have been reported in the literature. (Disser. Abstr.)

41970 ENERGY LEVELS OF ^{16}N FROM THE $^{18}O(d,\alpha)^{16}N$ REACTION. Bonner, Tom Ivan. Madison, Wis., Univ. of Wisconsin, 1968. 118p.
Thesis.
Energy levels of ^{16}N up to an excitation energy of 10.3 MeV were studied by use of the $^{18}O(d,\alpha)^{16}N$ reaction. Data were obtained at selected deuteron energies ranging from 4.75 to 11.5 MeV and for laboratory angles from 14 to 166°. The target was O_2 gas enriched to approximately 96% in ^{18}O and contained at pressures of approximately 30 mm Hg in a gas cell with a 2500 Å nickel foil window. The reaction alphas were detected with a $\Delta E \times E$ silicon detector telescope with an overall experimental resolution of ≥70 keV. Energy levels between 8.4 and 10.3 MeV were identified at energies of 8.49 ± 0.03, 8.819 ± 0.02, 9.035 ± 0.02, 9.459 ± 0.02, 9.794 ± 0.02, 9.90 ± 0.03 and 10.055 ± 0.02 MeV. Additional levels were tentatively identified at 9.16 ± 0.03, 9.34 ± 0.03, 9.66 ± 0.04, 10.17 ± 0.03, and 10.26 ± 0.03 MeV. The excitation function and angular distributions are presented for the levels with excitation energies of 0 = 0.120 (unresolved), 0.300 = 0.399 (unresolved), 3.36, 3.52, 3.96, 4.32 = 4.39 (unresolved), 4.77, 5.52, and 5.73 MeV. The data indicate that most of the groups below 4.4 MeV excitation are populated sufficiently by a deuteron pickup reaction that tentative information can be obtained on the spins and parities of these levels. The data on the 3.96 MeV level which exhibits an L = 2 pickup pattern coupled with previously published results indicate that the most probable spin and parity are 2^+ or 3^+. The absence of any apparent direct reaction in the angular distributions for the 3.52-MeV level suggests that the state has little ^{18}O parentage. The observed levels at 8.819, 9.794, and 10.055 MeV appear to be correlated with thresholds for neutron emission to excited states of ^{15}N. An explanation is suggested for this correlation in terms of a Wigner cusp effect which is enhanced by the presence of a nearby state of the proper spin and parity. It is argued that these states and certain other states of ^{16}N might be considered as a neutron bound or virtually bound in an s-state to an excited state of ^{15}N. Several features of this model should be amendable to experimental confirmation. This interpretation, if substantiated, would indicate that the potential well presented by the ^{15}N excited state decreases in strength with increasing ^{15}N excitation energy. (Disser. Abstr.)

41971 FINAL-STATE PROTON SPECTROSCOPY IN THE REACTION $^{14}N(^3He,\alpha)^{13}*N$ (p + ^{12}C). Bhatia, Tarlochan Singh. College Park, Md., Univ. of Maryland, 1967. 87p.
Thesis.
An experiment to measure the angular correlation between α particles (emitted in the beam direction) and protons was performed for the reaction $^{14}N(^3He,\alpha)^{13}*N$ (p)^{12}C. The energy distribution of α particles indicates that the reaction does indeed proceed through intermediate states in $^{13}*N$, but that two excited states (E_x = 3.51 and 3.56 MeV, Γ = 55 keV and 61 keV respectively) overlap. Using the previously known spins and parities of these two states ($J^\pi = 3/2^-$ and $5/2^+$, respectively), it is shown from the experiment that independent of the reaction mechanism, both states must be populated in comparable amounts. A distorted-wave Born-approximation analysis in terms of neutron pickup shows that if this is the reaction mechanism, and if multiple excitation processes are ignored, then the ratio of amplitude for production of the $5/2^+$ state to that for production of the $3/2^-$ state at $E_{^3He}$ = 5 MeV is 0.4; therefore there must be considerable $(d_{\frac{5}{2}})^2$ admixture in the predominantly $(p)^{10}$, ^{14}N ground-state configuration; and another energy-dependent reaction mechanism must be important for $E_{^3He}$ near 6 MeV. Neutron pickup is inadequate to explain the correlations at $E_{^3He}$ = 5.5, 6.0, and 6.4 MeV. These conclusions are independent of the choice of distorting potentials, because the α particle was detected in the beam direction. (Disser. Abstr.)

41972 PHOTONEUTRON SPECTRA OF CARBON AND BERYLLIUM. Augustson, Ronald Henning. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 172p.
Thesis.
The photoneutron spectra of ^{12}C and ^9Be were measured at 67.5° to the photon beam for six bremsstrahlung endpoint energies ranging from 35 to 80 MeV, using analyzed electrons from the Rensselaer Linac. Each spectrum was photon normalized by using the induced (γ,n) activity in a thin cobalt foil mounted on each sample. Absolute cross sections as a function of photon energy were obtained for (γ,n) reactions which leave the residual nucleus in its ground state and excited states below the particle emission threshold of the residual nucleus. The absolute values were determined by a comparison with the deuteron photoneutron yield also measured during the experiment. By subtracting one spectrum from the spectrum with the next higher endpoint and removing the contribution from ground and lower-lying excited state transitions, the cross section for production of neutrons with kinetic energy greater than 12 MeV which leave the residual nucleus with excitation energy in excess of the particle separation energy, was also determined. For these cross sections, the neutron production is due to photons in an energy bin about 10 MeV wide. The carbon ground state cross section falls smoothly from a value of 0.13 mb/st at E_g = 40 MeV to about 0.02 mb/st at 70 MeV. The contribution from transitions which leave ^{11}C in a state with 4- to 5-MeV excitation energy also falls in a similar way but has about 50% the cross section. These results agree with a calculation by Shklyarevsky in which he included n-p correlations in the ^{12}C ground-state nucleus. The production of neutrons greater than 12 MeV going to higher states in ^{11}C appears to set in at a photon energy of 50 MeV and to have a cross section of 0.07 mb/st by 70 MeV, where it dominates the neutron emission process. The neutron spectra and absolute cross section of this higher excitation cross section is consistent with a simple quasi-deuteron model. $^9Be(\gamma,n)$ transitions to the ^8Be ground state are found to be very weakly excited above 40 MeV, being estimated to have a cross section less than 0.007 mb/st above this energy. The cross section for (γ,n) leading to the 2.90 ^8Be state falls from 0.035 mb/st at 40 MeV to less than 0.007 mb/st at 70 MeV, while the cross section leading to the broad 11.4 MeV state is about constant at a value of 0.025 mb/st from 50- to 80-MeV photon energy. Transitions to higher excited states again dominate the neutron producing cross sections, being 0.12 mb/st at E_g = 70 MeV. (Disser. Abstr.)

41973 PROTON POLARIZATION IN THE REACTION $^{12}C(d,p)^{13}*C$(3.09 MeV) NEAR E_d = 3.0 MeV. Herbert, Nicholas Charles. Stanford, Calif., Stanford Univ., 1967. 84p.
Thesis.
The polarization of protons from the reaction $^{12}C(d,p)^{13}*C$ (3.09 MeV)(Q = −0.36 MeV) was measured at three bombarding energies (E_d = 2.8, 3.0, and 3.2 MeV) at angles between 40 and 120°. The reaction $^7Li(p,^4He)^4He$ was used as a polarization analyzer. The angular distribution of polarization was roughly similar at each bombarding energy. Polarizations as high as 30% were observed. These results were compared to the polarization of protons of equivalent energies scattered elastically from ^{12}C. This comparison is motivated by a recent direct interaction theory advanced by C. A. Pearson and M. Coz. The observed agreement suggests that "proton-core" elastic scattering may be an important process in producing the polarization observed in particular (d,p) reactions. (Disser. Abstr.)

41974 INVESTIGATION OF ^{16}O LEVELS UP TO 14-MeV EXCITATION ENERGY BY INELASTIC ELECTRON SCATTERING. Stroetzel, Martin (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 214: 357-73(1968). (In German).
Using electrons with up to 60 MeV energy, ten transitions in ^{16}O were studied: two E0 (6.05 and 12.05 MeV), one E1 (13.10 MeV), four E2 (6.92, 9.85, 11.52 and 13.1 MeV), two M2 (12.53 and 12.96 MeV), and one E3 (6.13 MeV). The cross sections measured as a function of momentum transfer were analyzed to yield transition probabilities to the ground state and transition radii. The results are compared with the theory of Brown and Green, and with the particle-hole calculations of Lewis and DeForest. For levels at 11.08 and 13.67 MeV, upper limits for the transition probabilities are given. (auth)

41975 ELASTIC SCATTERING OF PROTONS BY ^{14}C. Harris, William Roland. College Park, Md., Univ. of Maryland, 1968. 156p.

Thesis.

The differential elastic scattering cross section for protons scattered from ^{14}C was measured for energies from 1.0 to 2.7 MeV at center-of-mass scattering angles of 39.2, 54.7, 90, 125.3, and 161.4°. Thin self-supporting carbon foils enriched to 10% ^{14}C were used as targets. Outgoing protons were analyzed with a 180° double-focusing magnetic spectrometer at the lower angles, while a solid-state detector was used at 161.4°. The experimental data were fitted using a theoretical expression derived from R-matrix theory and accurate in the "two-level" approximation. Anomalies at incident proton energies of 1.162, 1.294, 1.472, 2.02, 2.074, and 2.48 MeV were observed. Best fit parameters (center-of-mass proton partial width in keV, center-of-mass total width in keV, and J^π) for these anomalies in the order listed are: 5.6, 7.9, $\frac{1}{2}^-$; 11.0, 34.0, $\frac{1}{2}^+$; 415.0, 419.0, $\frac{1}{2}^+$; 1.7, 14.0, $\frac{5}{2}^+$; 16.6, 47.0, $\frac{3}{2}^-$; 80.0, 80.0, $\frac{5}{2}^+$. Although these widths are lower than those previously reported, they are in essential agreement with published data. Uncertainty concerning certain previous J^π assignments has been removed. (Disser. Abstr.)

41976 CROSS SECTIONS OF THE REACTIONS INDUCED BY 125-MeV PROTONS ON CARBON, NITROGEN, AND OXYGEN NUCLEI. Jacquot, Claude; Jung, Monique; Baixeras-Aiguabella, Carmen; Braun, Henri; Schmitt, Roger (Centre de Recherches Nucleaires, Strasbourg-Cronenbourg). Compt. Rend., Ser. A and B, 266: 1286-8(May 6, 1968). (In French).

On the basis of the results of a general investigation of the reactions of 125-MeV protons with light emulsion nuclei involving the emission of less than 2 neutrons, the cross sections of the reactions observed, the abundances of the fragments emitted, and the distribution of the energies/nucleon of the fragments are given. (D.C.W.)

41977 STUDY OF STATES IN ^{12}C BY THE REACTION $^{11}B(\tau,d)$ ^{12}C. Bohne, W.; Homeyer, H.; Morgenstern, H.; Scheer, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A115: 457-60(1968).

Angular distributions of deuterons from transitions to nine states of ^{12}C are measured in the reaction $^{11}B(\tau,d)^{12}C$; spectroscopic factors were extracted and compared to recent (d,n) measurements. For the 14.71-MeV state, negative parity and a probable spin of 1 or 2 were found. (auth)

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Refer also to abstracts 41949, 41952, 41953, 41977, 42033, 42071, 42087, 42091, and 42094.

41978 (BNL-12621) GAMMA-RAY SPECTROSCOPY IN LIGHT NUCLEI: ^{22}Na, AN EXAMPLE. Olness, J. W. (Brookhaven National Lab., Upton, N. Y.). [1968]. 42p. (CONF-680440-1). Dep. CFSTI.

From 3rd International Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kan.

The applicability of some techniques of γ-ray spectroscopy to the study of light nuclei is demonstrated using some investigations of ^{22}Na as an example. ^{22}Na was formed in its various states using reactions such as $^{19}F(\alpha,n)^{22}Na$ and $^{20}Ne(^3He,p)^{22}Na$ as well as β decay to ^{22}Na. The investigations that are discussed deal with high-resolution measurements of γ spectra, β decay to states of ^{22}Na, angular correlation studies, linear polarization of γ rays, Doppler-shift attenuation measurements of lifetimes, and measurements of magnetic moments. (D.C.W.)

41979 (ORNL-4249) CALCULATED ^{56}Fe NEUTRON SCATTERING AND GAMMA-RAY PRODUCTION CROSS SECTIONS FROM 1.0 TO 7.6 MeV. Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 33p. Dep. CFSTI.

Measurements of neutron elastic and inelastic scattering from ^{56}Fe, which were recently extended to incident neutron energies of 7.6 MeV, were analyzed theoretically. The shape-elastic cross sections, calculated with an optical model potential using fixed values of the parameters, added to the compound elastic contribution obtained from a Hauser-Feshbach calculation including width fluctuation corrections, agree reasonably well with the data from 4.0 to 7.6 MeV. Inelastic scattering cross sections from a Hauser-Feshbach calculation agree well with the data from 1 to 7.6 MeV. The following quantities are tabulated: differential elastic scattering cross sections at 4.00, 4.60, 5.00, 5.56, 6.12, 6.53, 7.00, and 7.55 MeV; differential cross section for inelastic scattering to the 0.846-MeV level at 4.60, 5.00, 5.56, 6.12, 6.53, and 7.55 MeV; angle-integrated compound elastic and inelastic cross sections at 1.0, 1.5, 2.0, 2.5, 3.0, 3.25, 3.5, 3.75, 4.0, 4.5, 5.0, 5.5, 6.2, 6.6, and 7.6 MeV; total, elastic, and reaction cross sections at 4.00, 4.60, 5.00, 5.56, 6.12, 6.53, and 7.55 MeV; and gamma-ray production cross sections for neutron energies from 1 to 7.6 MeV. (auth)

41980 PRECISION MEASUREMENTS OF THE HALF-LIVES OF ^{19}Ne, ^{23}Mg, ^{26m}Al, ^{27}Si, AND ^{63}Zn. Goss, J. D.; Riffle, F. L.; Parsignault, D. R.; Harris, J. C. (Ohio State Univ., Columbus). Nucl. Phys., A115: 113-19(1968).

The half-lives of the radioisotopes ^{19}Ne, ^{23}Mg, ^{26m}Al, ^{27}Si, and ^{63}Zn were measured and found to be 17.36 ± 0.06 sec, 11.41 ± 0.05 sec, 6.38 ± 0.06 sec, 4.17 ± 0.01 sec, and 38.4 ± 0.1 min, respectively. A systematic error in half-life measurements due to pile-up in cross-over timing systems was investigated. (auth)

41981 STATIC QUADRUPOLE INTERACTION OF ^{44}Sc IN BARIUM TITANATE. Glass, J. C.; Kliwer, J. K. (Univ. of Nevada, Reno). Nucl. Phys., A115: 234-40(1968).

The electric quadrupole interaction in polycrystalline barium titanate is investigated by observing the perturbed directional correlation of the ^{44}Sc gamma-gamma cascade. The time-differential attenuation factor as well as the integral attenuation factor show that the spin of the ^{44}Sc first excited level is given by I = 1. The interaction frequency is found to be ω_0 = 30.6 ± 1.5 MHz which corresponds to an interaction strength of 26.8 ± 1.3 nV. The time-differential attenuation factor shows the effects of a probability distribution for the field gradient with a relative width of δ = 25%. No evidence of rhombic fields or after-effects is found. (auth)

41982 OPTICAL-MODEL ANALYSIS OF ALPHA-PARTICLE SCATTERING BY ^{40}Ca FROM 12 TO 18 MeV. Robinson, C. P.; Aldridge, J. P.; John, Joseph; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev., 171: 1241-9(July 20, 1968).

Sixty-four point angular distributions for the elastic scattering of α particles by ^{40}Ca were measured from 12 to 18 MeV in 100-keV intervals. The angular range is from 26.7 to 176.1° (c.m.). Optical-model fits to these data were obtained, using a Woods-Saxon real potential and a surface imaginary potential with a form given by the derivative of a Woods-Saxon function. The real well-radius value of 5.2 F was taken from previous analyses of electron scattering data. A consistent set of the other geometric parameters was chosen by fitting a representative set of five angular distributions covering the entire energy range. With the geometric parameters thus fixed, two-parameter fits to all of the data have been obtained in which the real and the imaginary potential strengths are varied. A fitting criterion which compensates for the large Rutherford contribution to the scattering at forward angles is introduced to improve the fits. Of the ten phase-equivalent potentials with real potential strengths less than 210 MeV, the three with average values of 25, 105, and 132 MeV are traced as functions of energy. A cluster-model calculation which places a bound α-particle state at −5.23 MeV in ^{44}Ti yields a potential-well depth of 136 MeV, in rather good agreement with the 132-MeV average value found in the scattering analysis. (auth)

41983 INELASTIC ELECTRON SCATTERING FROM ^{24}Mg AT 180°. Fagg, L. W.; Bendel, W. L.; Tobin, R. A.; Kaiser, H. F. (Naval Research Lab., Washington, D. C.). Phys. Rev., 171: 1250-4(July 20, 1968).

The 180° inelastic electron scattering from ^{24}Mg was studied at bombarding energies of 39 and 56 MeV. A survey was made of the giant-resonance region from 14 to 28 MeV. The excitation region from 9 to 14 MeV was treated more intensively in order to study the analogs of states in ^{24}Na. Measurement of the transition radius R and the ground-state transition width Γ for the 9.94- and 10.70-MeV levels yielded R = 3.5 ± 0.2 F, Γ = 11.9 ± 2.7 eV and R = 3.0 ± 0.2 F, Γ = 18.9 ± 3.7 eV, respectively. The relation of these results to Kurath's theory is discussed. (auth)

41984 ENERGY LEVELS OF ^{48}Sc. McDonald, W. J. (Univ. of Alberta, Edmonton); Sample, J. T.; Sheppard, D. M.; Stinson, G. M.; Jones, K. W. Phys. Rev., 171: 1254-7(July 20, 1968). (BNL-12272).

The energies of neutrons emitted in the $^{48}Ca(p,n)^{48}Sc$ reaction at proton energies of 4.5 and 5.5 MeV were determined by a time-of-flight technique. The level structure of ^{48}Sc was deduced up to 4.3-MeV excitation. The Q-value determined for the $^{48}Ca(p,n)^{48}Sc$ reaction is −506 ± 7 keV. (auth)

41985 NUCLEAR RESONANCE FLUORESCENCE IN ^{65}Cu. Metzger, F. R. (Bartol Research Foundation, Swarthmore, Pa.).

Contract AT(30-1)-3525. Phys. Rev., 171: 1257-60(July 20, 1968). (NYO-3525-27).

The Coulomb fragmentation of $^{65}ZnI_2$ molecules was utilized as the means of producing γ rays which are resonant with the 1.116-MeV level in ^{65}Cu. A study of the resonant self-absorption led to a mean lifetime $\tau = 3.80 \pm 0.25 \times 10^{-13}$ sec for this level. From the angular distribution of the resonant radiation, the mixing amplitude δ for the M1 + E2 1.116-MeV ground-state transition was determined as $\delta = -0.437 \pm 0.015$. (auth)

41986 GAMMA RADIATION FROM THE REACTIONS $^{20}Ne(\alpha,\alpha'\gamma_{1.63})^{20}Ne$ AND $^{20}Ne(\alpha,p\gamma_{0.44})^{23}Na$. Spear, R. H. (Univ. of Manchester, Eng.); Wright, I. F. Aust. J. Phys., 21: 307-16 (June 1968).

Excitation functions for γ radiation from the reactions $^{20}Ne(\alpha,\alpha'\gamma_{1.63})^{20}Ne$ and $^{20}Ne(\alpha,p\gamma_{0.44})^{23}Na$ were studied for bombarding energies from 3.96 to 6.08 MeV. Angular distribution measurements provide spin and parity assignments for 2^+ for ^{24}Mg levels at excitation energies of 12.74 and 12.81 MeV, and 4^+ or 5^- (possibly 6^+) for a level at 12.98 MeV. (auth)

41987 PROTON POLARIZATION FROM THE $^{40}Ca(d,p)^{41}Ca$ REACTION AT 5 MeV. Leighton, H. G.; Roy, G.; Gurd, D. P. (Univ. of Alberta, Edmonton). Nucl. Phys., A115: 108-12 (1968).

The polarization of the protons from the ground state $^{40}Ca(d,p)^{41}Ca$ reaction was measured for an incident deuteron energy of 5 MeV and in the angular range from 25 to 115°. The polarization showed the same trends found in higher energy experiments, namely small and negative in the forward direction with an indication of a negative peak in the vicinity of 100°. DWBA calculations, including a vector type spin-orbit potential, predicted in all cases polarizations opposite in sign to those observed experimentally. (auth)

41988 $^{48}Ti(\alpha,\alpha')$ REACTION AND SYSTEMATICS OF OCTUPOLE STATES IN THE Ti ISOTOPES. Bernstein, A. M.; Lippincott, E. P.; Sample, G. T.; Thorn, C. B. (Massachusetts Inst. of Tech., Cambridge). Contract(AT 30-1)-2098. Nucl. Phys., A115: 79-96(1968). (MIT-2098-427).

The reaction $^{48}Ti(\alpha,\alpha')$ was studied at 31 MeV with 100-keV resolution and high statistics. Spin and parity assignments were made on the basis of the systematic shapes of the differential cross sections and by comparison with distorted-wave Born approximation calculations. These assignments were made up to an excitation energy of 6.4 MeV. The magnitudes of the cross sections were related to electromagnetic transition rates by use of the vibrational model. Based on the assumption of pure $1f_{7/2}$ configurations, the lowest 4^+ and the second 2^+ states should be excited by two-step processes only. The differential cross sections for these states do not support this hypothesis. The most interesting feature of the results is the identification of seven 3^- states in ^{48}Ti ranging in excitation energy from 3.36 to 6.33 MeV which vary in strength from 1 to 3 Weisskopf units. Three 3^- states of comparable strength have been previously located in ^{46}Ti and five 3^- states in ^{50}Ti. The strongest of these states has 3.5 Weisskopf units in ^{46}Ti and 7 Weisskopf units in ^{50}Ti. The weakness of the octupole states in this region compared to the 26 Weisskopf units found for the lowest 3^- state in ^{40}Ca is surprising and may be difficult to reconcile with our understanding of current microscopic descriptions of this mode. (auth)

41989 STUDY OF γ-RAY TRANSITIONS IN ^{26}Al. Bissinger, G. A.; Quin, P. A.; Chagnon, P. R. (Univ. of Notre Dame, Ind.). Nucl. Phys., A115: 33-48(1968).

The decay scheme of excited levels of ^{26}Al up to 4000 keV, produced by the reaction $^{24}Mg(^3He,p)^{26}Al^*$, was investigated. The two-parameter p-γ coincidence spectra indicate decay modes for some levels which differ from the literature. The results are consistent with the existence of a triplet near 2070 keV, as indicated by recent $^{25}Mg(p,\gamma)$ work. The upper member of the triplet, at 2071.5 keV, was found to branch <91% to the 228-keV first excited state and <9% to the 1058 keV $J^\pi = 1^+$, T = 0 third excited state. Directional correlation measurements with axially symmetric reaction geometry lead to definite spin assignments J = 1 for the three levels at 1850, 2071.5, and 2740 keV. (auth)

41990 THE REACTOR NEUTRON CAPTURE CROSS SECTION OF ^{46}Sc AND A DETERMINATION OF THE BETA BRANCHING RATIO OF ^{47}Sc DECAY. Bak, Zong-Tschun; Riehs, P. (Reaktorzentrum, Seibersdorf, Austria). Int. J. Appl. Radiat. Isotop., 19: 593-6(July 1968).

The capture cross section of ^{46}Sc, which might limit the usefulness of ^{45}Sc as a thermal neutron flux monitor, was determined as 7.5 ± 1.7 b (statistical errors 2σ = 0.5 b, added systematic errors ±1.2 b) by activity measurements. By means of a 4π beta-gamma coincidence measurement and a calibrated gamma-ray detector, the relative intensity of the low-energy beta transition of ^{47}Sc was found to be 0.685 ± 0.027 per decay (statistical error negligible, systematic errors added). (auth) (UK)

41991 ANALOG STATES AND VIRTUAL LEVELS IN ^{49}V FROM THE REACTION $^{48}Ti(p,\gamma)^{49}V$. Klapdor, H. V. (Univ., Hamburg). Nucl. Phys., A114: 673-84(1968). (In German).

The $^{48}Ti(p,\gamma)$ excitation curve was measured for proton bombarding energies of 1335 to 2290 keV. From the (p,γ) resonances, 161 new virtual levels in the region of 8064 to 8990 keV excitation energy in ^{49}V were determined. Level spacings are compared with statistical-model predictions. Some prominent resonances are identified as isobaric analogue states corresponding to low-lying excited states in ^{49}Ti. Shell effects seem to appear for the Coulomb displacement energies. (auth)

41992 AN ANALYSIS OF THE REACTION $^{39}K(d,\alpha)^{37}Ar$ ON THE BASIS OF THE STATISTICAL MODEL. Naude, W. J.; Bottega, A.; McMurray, W. R. (Southern Universities Nuclear Inst., Faure, South Africa). Nucl. Phys., A114: 551-60(1968).

The reaction $^{39}K(d,\alpha)^{37}Ar$ to the ground and first five excited states of ^{37}Ar was studied in the energy range 4.55 to 5.32 MeV. Fluctuations in the excitation functions were analyzed using the Ericson fluctuation theory. Average cross sections were compared with those calculated using the Hauser–Feshbach theory. The probable spins of the excited levels in ^{37}Ar as obtained from fluctuation analysis and Hauser–Feshbach fits generally agree with available spin assignments. No previous assignment is available for the third excited state at 2.22 MeV for which a most probable spin of ($\frac{5}{2}$, $\frac{7}{2}$) is deduced. Analysis of the fluctuations gives a value of the coherence width $\Gamma = 17 \pm 3$ keV at an excitation of 19 MeV in the compound nucleus ^{41}Ca. (auth)

41993 A STUDY OF THE 3.00-MeV LEVEL OF ^{27}Al VIA $^{24}Mg(\alpha,p\gamma)^{27}Al$. Kean, D. C.; Elliott, R. V.; Spear, R. H. (Australian National Univ., Canberra). Aust. J. Phys., 21: 405-7 (June 1968).

The reaction $^{24}Mg(\alpha,p\gamma)^{27}Al$ at 9 MeV was used to investigate the spin of the 3-MeV level of ^{27}Al and the possibility that the level is a doublet. The study was performed in order to test the validity of the excited-core model for ^{27}Al. The angular correlation of γ rays in coincidence with protons populating the 3-MeV level was measured. The correlations of the 3.00-0 and 3.00-2.21 γ-ray transitions were analyzed assuming $J = \frac{5}{2}$ for the ground state and making fits for possible values of the spin of the 3.00-MeV level. The results support an assignment of $J = \frac{5}{2}$ to the 3.00-MeV level. Branching ratios for the 3.00-MeV state were also determined. The results of the study indicate that a doublet character of the 3.00-MeV level is very improbable. (D.C.W.)

41994 RESONANCE WIDTH MEASUREMENTS USING THE DOPPLER-SHIFT ATTENUATION METHOD. Anyas-Weiss, N.; Litherland, A. E.; Roepke, H. (Univ. of Toronto). Phys. Lett., 27B: 161-3(June 24, 1968).

Resonance widths were measured in ^{25}Al at E_x = 3422 and 4038 keV and in ^{28}Si at E_x = 12,171 keV, by observing the attenuated Doppler shift of the primary γ rays following the radiative capture of protons in ^{24}Mg and ^{27}Al. (auth)

41995 PARTICLE-CORE COUPLING IN ^{89}Sr. Auerbach, N. (Yale Univ., New Haven). Phys. Lett., 27B: 127-31(June 24, 1968).

The particle-plus-core coupling model is used to describe the spectrum of ^{89}Sr. The model provides an adequate interpretation of the $^{88}Sr(d,p)^{89}Sr$ stripping experiments and the $^{88}Sr(p,p')^{88}Sr$ analog measurements recently performed. (auth)

41996 CONVERSION COEFFICIENT OF ^{69m}Zn AND FLUORESCENT YIELD OF ZINC. Schmolz, A.; Hoffmann, K. W. (Univ., Stuttgart). Z. Phys., 214: 1-6(1968). (In German).

The decay of ^{69m}Zn and ^{69}Zn was investigated using a radioactive source obtained by irradiating a sample of 99% ^{68}ZnO with neutrons. The β spectrum of ^{69}Zn and the conversion electrons of the ^{69m}Zn decay were studied with an anthracene scintillation spectrometer of the split crystal type. The measured value of the conversion coefficient of ^{69m}Zn is $\alpha = 0.054 \pm 0.003$. With this result and those obtained by measurement of the γ-ray spectra of ^{69m}Zn with NaI(Tl) scintillation crystals, the K-fluorescent yield of Zn was determined to be $\omega_K = 0.45 \pm 0.04$. (auth)

41997 REACTOR CROSS SECTION OF THE REACTION $^{41}K(n,\alpha)^{38}Cl$ AND ITS INTERFERENCE IN ACTIVATION ANALYSIS. Johansen, O.; Steinnes, E. (Institutt for Atomenergie, Kjeller, Norway). Radiochim. Acta, 9: 47-9(May 1968).

Samples of K_2CO_3 were irradiated near the center of the JEEP 1 core, where the thermal neutron flux density was about 2.5×10^{12} n/cm^2-sec and the fast flux density was about 1.5×10^{11} n/cm^2-sec.

The ^{38}Cl activity was separated and was counted using an NaI(Tl) spectrometer to record the gamma spectra. A mean value of 0.68 ± 0.05 mbarn was obtained for the cross section of the reaction. The reaction cross section was measured to determine its interference in the determination of Cl in rocks. (D.C.W.)

41998 EFFECTIVE CROSS SECTIONS FOR THE REACTIONS $^{40}Ca(n,2n)^{39}Ca$ AND $^{44}Ca(n,p)^{44}K$ WITH 14-MeV NEUTRONS. Braun, H.; Schulze, W. (Freie Univ., Berlin). Radiochim. Acta, 9: 22-6(May 1968). (In German).

By the activation method, the cross sections for the neutrons at an energy of 14.69 ± 0.05 MeV of the reactions $^{40}Ca(n,2n)^{39}Ca$ and $^{44}Ca(n,p)^{44}K$ were determined to be 8 ± 2 mbarn and 35 ± 3 mbarn, respectively. Until now the cross section of the first reaction had not been measured. The result for the second radiation is in agreement with Levkovskii's value (37 ± 7 mbarn) and lies within the error range reported by Hille (25 ± 12 mbarn). (auth)

41999 RADIATIVE CAPTURE OF ^{3}He AND ^{4}He IONS IN HEAVY NUCLEI. Carlson, Richard V. Lafayette, Ind., Purdue Univ., 1967. 249p.

Thesis.

In order to investigate the effect of particle composition on the probability of radiative capture, excitation functions were determined for radiative capture of 5- to 42-MeV ^{4}He ions by ^{115}In and ^{127}I; of 2- to 33-MeV ^{3}He ions by ^{41}K, ^{45}Sc and ^{71}Ga; and of 8- to 22-MeV ^{2}H ions by ^{208}Pb. The (α,γ) excitation functions are closely similar, rising to maxima of 150 to 170 μb at about 17-MeV bombarding energy and falling to less than 10 μb above 30 MeV. At energies above the Coulomb barrier, the $(^{3}He,\gamma)$ cross sections are essentially constant at about 20 μb for $^{41}K(^{3}He,\gamma)$, 15 μb for $^{45}Sc(^{3}He,\gamma)$ and 25 μb for $^{71}Ga(^{3}He,\gamma)$. The (d,γ) excitation function rises to about 20 μb at 11 MeV and falls to 5 μb at 21 MeV. These results as well as all other reported cross sections for radiative capture of composite particles are compared with calculated excitation functions based on statistical theory. For excitation energies up to about 25 MeV there is reasonable agreement between statistical theory predictions and the (α,γ) and (d,γ) experimental cross sections; in particular the variation of over two orders of magnitude in the peak cross sections reported for different α-capture reactions is accounted for. The agreement is not so satisfactory at higher energies where, however, the calculated values are less reliable due to the doubtful nature of some of the assumptions which are necessary to take account of angular momentum effects and multiple photon cascades to particle-stable states. From these results it is concluded that there is no current evidence for mechanisms other than compound nucleus formation and decay in the radiative capture of deuterons and alpha particles. Effects due to the different penetrabilities of various projectiles are allowed for by dividing the experimental capture cross sections by the relevant total reaction cross sections. The (nucleon,γ), $(^{3}He,\gamma)$ and (α,γ) results fall into three distinct ranges and strong support is provided for the proposal that nucleon capture proceeds predominantly by a direct or collective electric dipole mechanism. In addition, there is definite evidence that similar non-statistical processes make strong contributions in the case of ^{3}He capture. (Disser. Abstr.)

42000 $(\alpha,\alpha'\gamma)$ ANGULAR CORRELATION STUDIES OF EXCITED STATES IN ^{24}Mg, ^{26}Mg, AND ^{28}Si. Canada, Thomas Robert. Bloomington, Ind., Indiana Univ., 1967. 100p.

Thesis.

The particle-gamma angular correlation method of Litherland and Ferguson was used to gain information on the decay modes and spin assignments of a number of excited states in ^{24}Mg, ^{26}Mg and ^{28}Si. These nuclei were excited by the $X(\alpha,\alpha')X^*$ reaction. This angular correlation technique utilizes a particular counter geometry to reduce the number of substates of X^* which are populated. By detecting the inelastically scattered alpha particles at 0 or 180° relative to the beam direction, only those substates with magnetic quantum numbers less than or equal to the sum of the spins of the incident particle, the target nucleus and the outgoing particle are population. This limit and the value of the spin of the state X^* constrain the angular distributions of the deexcitation gamma rays originating from X^*. In the present work the inelastically scattered alpha particles were detected in an annular counter at 180° to the beam. The gamma-rays were detected in a 5 in. × 5 in. NaI(Tl) crystal between 40 and 90° with respect to the beam direction. In ^{28}Si J^π assignments of 3^-, 1^-, 2^+, 2^+, and 1^- are made to the levels at 6.88[a], 7.38, 7.41, 7.93, and 8.94 MeV, respectively. A state of approximately 8.44 MeV was found to decay through the 4.61 (4^+) MeV level. Angular distribution measurements favor a $J^\pi = 6^+$ assignment to this level. In ^{26}Mg a most probable J^π assignment of 2^+ is made to the 4.90 MeV level. With this J^π assignment the mixing ratio of the 4.90 (2^+) → 1.81 (2^+) MeV transition is $-(2.75^{+\frac{1}{2}}_{-\frac{1}{4}})$. A mixing ratio of x = 0.087 ± 0.045 was obtained for the 2.94 (2^+) → 1.81 (2^+) MeV transition. In addition a ^{26}Mg decay scheme involving a number of levels above 4.33 MeV is proposed. In ^{24}Mg J^π assignments of $2^+ + 1^-$ are made to the 7.35 + 7.56-MeV and 9.00 + 9.15-MeV doublets. The 8.44-MeV state is assigned $J^\pi = 1^-$. The level structures of ^{24}Mg, ^{26}Mg, and ^{28}Si are compared qualitatively in terms of a rotation-vibration model. In particular, it is proposed that the low-lying levels of ^{26}Mg arise from collective excitations of the nucleus in its ground state and in a particle state at 3.58 MeV. (Disser. Abstr.)

42001 CROSS-SECTION ANGULAR DISTRIBUTIONS FOR $^{40}Ca(d,d)$ AND (d,p) REACTIONS, AND PROTON POLARIZATION NEAR A J-DEPENDENT MINIMUM. Foster, Charles Carlton. Bloomington, Ind., Indiana Univ., 1967. 166p.

Thesis.

Present theories of the mechanism of the deuteron stripping reaction are unable to account for certain crucial observed features, such as the dependence of the cross-section angular distribution of the outgoing protons on the total angular momentum transfer (J-dependence) and the spin polarization of these protons. To provide additional information for theoretical comparisons the following work has been carried out. Differential cross-section angular distributions were measured at 11-MeV incident deuteron energy for the elastic scattering of deuterons from calcium, and for the $^{40}Ca(d,p)$ reactions exciting the ground, 1.95-MeV, 2.47-MeV and 3.95-MeV states of ^{41}Ca. The results of these measurements are compared with the results of other measurements at the same energy. Agreements and discrepancies between the results are discussed. Proton polarization measurements were obtained at three angles, 86, 98.9, and 111.7 in the center of mass system, across the J-dependent minimum in the cross-section angular distribution for the $^{40}Ca(d,p)$ reaction exciting the 3.95-MeV state of ^{41}Ca. Results for these polarization measurements are −0.128 ± 0.039, +0.061 ± 0.046 and +0.151 ± 0.041 respectively. Qualitatively, the polarization angular distributions passes smoothly through zero with positive slope near the J-dependent minimum in the angular distribution. A scattering chamber-polarimeter assembly for the simultaneous measurement of the polarization of protons from (d,p) reactions exciting several low-lying states in the same nucleus was designed and fabricated. Tests have shown that this assembly is very flexible and that it can be used to simultaneously measure the polarization of protons exciting several low-lying states in ^{29}Si in a (d,p) reaction. (Disser. Abstr.)

42002 DECAY OF ^{78}Rb AND ^{79}Rb. Toeset, C. J.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta, 9: 55-6(May 1968).

Samples of ammonium bromide were irradiated for 1 min with ^{3}He ions. By dissolving the irradiated samples in H_2O and adding RbI, Na_2SO_3, and $HClO_4$, $RbClO_4$ was obtained and was counted, about 5 min after irradiation, using a Ge(Li) spectrometer. Activities with half-lives of 6 and 24 min were observed and were attributed to ^{78}Rb and ^{79}Rb, respectively. The energies and relative intensities of a number of γ rays were determined. (D.C.W.)

42003 PRECISE DETERMINATION OF THE $\bar{P}_K\omega_K$-VALUE AND THE FLUORESCENCE YIELD ω_K OF Cu AFTER ELECTRON CAPTURE DECAY OF ^{65}Zn. Bambynek, W.; Reher, D. (EURATOM, Geel, Belgium). Z. Phys., 214: 374-80(1968).

The $\bar{P}_K\omega_K$-value of Cu following ^{65}Zn decay was determined to be 0.3866 ± 0.0017 using two independent methods for the measurements of the K x-ray emission rate. With $\bar{P}_K$ = 0.887 deduced from literature the fluorescence yield of Cu was found to be ω_K = 0.436 ± 0.003. (auth)

42004 NEUTRON CAPTURE IN LOW ABSORPTION MATERIALS. Hockenbury, Robert Wesley. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 178p.

Thesis.

Neutron capture in sodium, aluminum, iron and nickel was measured from 1 to 200 keV with a 1.25-meter-diameter liquid scintillation detector at the Rensselaer Linac. Many more resonances were observed in the capture measurements of Fe and Ni than were seen in total cross section experiments. The radiation width or $\sigma_0\Gamma_\gamma$ was determined for most of the observed resonances. The radiative widths determined in ^{56}Fe and Al are not constant from resonance to resonance. Those resonances not previously observed are assigned to p-wave neutrons and the p-wave strength function is computed to be 0.1 ± 0.05 × 10^{-4} for both ^{56}Fe and ^{58}Ni. (Disser. Abstr.)

42005 $^{27}Al(n,n'\gamma)$ REACTIONS AND THE 3002-keV LEVEL. Chung, K. C.; Velkley, D. E.; Brandenberger, J. D.; McEllistrem, M. T. (Univ. of Kentucky, Lexington). Nucl. Phys., A115: 476-80(1968).

The neutron inelastic scattering cross sections to the 2980- and 3002-keV levels of ^{27}Al have been separately determined from the $(n,n'\gamma)$ reactions to those levels and the known branching ratios

for their decay. The cross sections are well reproduced by Hauser–Feshbach formalism calculations. The angular distribution of γ-rays from the 3002 keV level is consistent only with J = 7/2 or 9/2 assigned to the level and supports the recent 9/2 assignment. The excitation energies of observed levels are 843, 1013, 2213, 2730, 2980, and 3002 keV, all ±1 keV. (auth)

42006 INVESTIGATION OF (n,2n) EXCITATION FUNCTIONS. Bormann, M.; Behrend, A.; Riehle, I.; Vogel, O. (Univ., Hamburg). Nucl. Phys., A115: 309-20(1968). (In German).

The activation method was used to measure (n,2n) excitation functions in the energy region 12.6 to 19.6 MeV for ^{52}Cr, ^{75}As, ^{85}Rb, ^{106}Cd, ^{112}Sn, ^{121}Sb, ^{140}Ce, ^{142}Ce, ^{141}Pr, ^{144}Sm, ^{165}Ho, and ^{181}Ta. Further, isomeric (n,2n) cross-section ratios were obtained for ^{85}Rb and ^{121}Sb in the energy region stated above and for ^{123}Sb and ^{144}Sm at 14.1 MeV. The total (n,2n) excitation functions were compared with results from statistical theory calculations using optical model absorption cross sections and the Fermi-gas model nuclear level density $\omega(E) = C(E + t)^{-2} \exp(2(aE)^{1/2})$. Particularly at lower excitation energies (near reaction thresholds) better agreement between theoretical and experimental cross sections has been obtained when the pairing effect in the level density was accounted for by using appropriate values for the factor C according to Brown and Muirhead instead of shifting the nuclear ground state by the pairing energy δ as usually is done in the literature. In most cases good agreement has been obtained with level density coefficients a from Abdelmalek and Stavinsky. From the isomeric cross-section ratios, spin cutoff factors σ were deduced applying the theory of Vandenbosch and Huizenga. These values of σ lead to moments of inertia for the nuclei considered which only amount to 20 to 50% of the rigid-body values. (auth)

42007 AN INVESTIGATION OF ELASTIC PROTON SCATTERING ON ^{26}Mg AND ^{30}Si. Walinga, Jacob. Utrecht, Rijksuniversiteit te Utrecht, 1967. 39p.

Thesis.

An extensive investigation of proton elastic scattering by ^{26}Mg and ^{30}Si is summarized under the following headings: a high-resolution investigation of the reaction ^{30}Si(p,p)^{30}Si; the isobaric analog state in ^{31}P of the 3.13-MeV level in ^{31}Si; and a high-resolution investigation of the reaction ^{26}Mg(p,p)^{26}Mg. (D.C.W.)

42008 CORE-EXCITATION CALCULATION OF j-FORBIDDEN REACTIONS. Strobel, George L. (Univ. of Georgia, Athens). Nucl. Phys., A115: 364-76(1968).

For each of the j-forbidden reactions ^{18}O(d,p)^{19}*O (E_x = 0.096 MeV), ^{42}Ca(d,p)^{43}*Ca (E_x = 0.374 MeV), and ^{44}Ca(d,p)^{45}*Ca (E_x = 0.176 MeV), a distorted-wave Born approximation calculation of the differential cross section was performed using, in addition to the usual direct stripping amplitude, a core-excitation amplitude calculated in the point deuteron approximation. Comparison with experiment is encouraging. (auth)

42009 RESONANCES IN EXCITATION FUNCTIONS FOR PROTON SCATTERING ON ^{23}Na AT ABOUT 6.5 MeV ENERGY. Vasil'ev, S. S.; Mikhaleva, T. N.; Chuprunov, D. L. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 5, 113-17(Sept.-Oct. 1967). (In Russian).

Angular distributions and excitation functions for proton elastic and inelastic scattering by ^{23}Na at energies of 6.25 to 6.72 MeV were studied in order to determine the mechanism for proton scattering by ^{23}Na. It was observed that each weak change in the angular distribution is accompanied by a resonance in the excitation function. (R.V.J.)

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Refer also to abstracts 40363, 40364, 40376, 41952, 41953, 42006, 42100, 42132, 42133, 42142, and 42143.

42010 (ANL-Trans-639) ANGULAR DISTRIBUTION OF FRAGMENTS OF PHOTOFISSION NEAR THE THRESHOLD. Kapitsa, S. P.; Tsipenyuk, Yu. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report FEI-73. 6p. Dep. CFSTI.

The results of an investigation of the photofission of ^{240}Pu, ^{242}Pu, ^{232}Th, and ^{238}U at bremsstrahlung endpoint energies of 5 to 8 MeV are presented. An interpretation of the data is outlined. (D.C.W.)

42011 (BNL-tr-219) MEASUREMENT OF THE RADIATIVE CAPTURE AND FISSION CROSS SECTION RATIOS FOR ^{235}U AND ^{239}Pu IN THE RESONANCE-NEUTRON ENERGY REGION. Ryabov, Yu. V.; Donssik, So; Chikov, N.; Yaneva, N. Translated by Stephen Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 24: 351-62(1968). 20p. Dep. CFSTI.

Time-of-flight measurements of the neutron fission cross sections and the neutron capture-to-fission ratios of ^{239}Pu and ^{235}U were made over energy ranges of 5 eV to 23 keV and of 0.15 eV to 30 keV, respectively. Capture and fission resonance integrals were obtained from the data. (D.C.W.)

42012 (INR-P-911) LOW ENERGY PART OF THE α PARTICLE SPECTRUM FROM TRIPARTITION OF ^{235}U. Chwaszczewska, J.; Dakowski, M.; Krogulski, T.; Piasecki, E.; Sowinski, M.; Stegner, A.; Tys, J. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 7p. Dep.

Measurement of the low-energy part of the spectrum of α particles emitted in thermal neutron fission of ^{235}U was performed with a telescope counter. The upper limit for the cross section of the ^{235}U(n,α) ^{232}Th reaction was estimated to be 3 mb for the transition to the ground state and 2 mb for the transition to the excited state up to 5 MeV. (auth)

42013 (JINR-E7-3868) ELECTRON-CAPTURE DECAY OF ^{204}Po. Kush, V.; Chuburkova, I. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 20p. Dep.

The gamma-ray spectrum from the electron–capture decay of ^{204}Po was investigated with the germanium detector, and the tentative energy levels scheme of ^{204}Bi was discussed. (auth)

42014 (JINR-P3-3882) NEUTRON RESONANCES OF THE GADOLINIUM ISOTOPES. Karzhavina, E. N.; Nguyen Nguyen Phong; Popov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 31p. (In Russian). Dep.

The transmission and yield of γ rays from the neutron capture for ^{152}Gd, ^{154}Gd, ^{155}Gd, ^{156}Gd, ^{157}Gd, ^{158}Gd, ^{160}Gd isotopes were measured with the help of a neutron spectrometer of the Neutron Physics Laboratory of the JINR. The parameters of the neutron resonances were determined, and some average characteristics of the Gd isotope nuclei were calculated. (auth)

42015 (JINR-P4-3925) EFFECT OF THE NUCLEUS DEFORMATION ON THE NEUTRON RESONANCE DENSITY IN THE RARE-EARTH REGION. Furman, V. I.; Popov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 16p. (In Russian). Dep.

The existence of a maximum in the dependence of a level density parameter from the A atomic weight at A ≈ 150 is pointed out. It is shown that the presence of this maximum can be explained by the scheme of one-particle states of deformed nuclei. (auth)

42016 (KAPL-P-3438) CAPTURE TO FISSION RATIOS OF ^{233}U, ^{235}U, ^{239}Pu, AND ^{241}Pu FOR RESONANCE ENERGY NEUTRONS. Eiland, H. M.; Esch, L. J.; Feiner, F.; Conrad, C. A. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 4p. (CONF-680601-31). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Highly enriched samples of ^{239}Pu, ^{241}Pu, ^{233}U, and ^{235}U were placed inside thick cylinders of Cd and Rh and were irradiated in a water channel in the core of a swimming pool reactor. The Cd and Rh filters were designed to stop essentially all neutrons below a cut-off energy of 2 to 4 eV. Effective capture integrals and fission integrals were calculated from the values that were obtained for total captures, total fissions, and neutron flux/unit lethargy. The effective capture and fission resonance integrals were corrected to a common cut-off energy and to a 1/E neutron spectrum; the ratio of the corrected resonance integrals was used to obtain the capture-to-fission ratios. (D.C.W.)

42017 (LA-tr-68-20) THE MEAN NUMBER OF PROMPT NEUTRONS IN THE FISSION OF ^{235}U AND ^{232}Th INDUCED BY NEUTRONS WITH ENERGY UP TO 3.3 MeV. Prokhorova, L. I.; Smirenkin, G. N. ([Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut]). Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from report FEI-107. 15p. Dep. CFSTI.

A battery of 36 ^{10}B F_3 counters in a paraffin block was used to measure $\bar{\nu}$ of ^{235}U and ^{232}Th. The fission events were recorded by a multilayer ionization chamber. The measurements of $\bar{\nu}$ for ^{232}Th were made within the range of neutron energies from 1.5 to 3.3 MeV; measurements of $\bar{\nu}$ for ^{235}U were made in the energy interval from 0.4 to 3.3 MeV at an interval of 0.2 MeV. The accuracy of the values of $\bar{\nu}$ is about 1.5% for ^{235}U and about 2.5% for ^{232}Th. The measurements were carried out by comparing with the thermal value of $\bar{\nu}$ of ^{235}U. (auth)

42018 (LA-tr-68-21) THE EFFECT OF THE EXCITATION ENERGY OF A FISSIONABLE NUCLEUS OF ^{239}U ON THE YIELD AND KINETIC ENERGIES OF FRAGMENTS. Vorob'eva, V. G.; Kuz'minov, B. D.; Sergachev, A. I.; Tarasko, M. Z. ([Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut]). Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from report FEI-108. 16p. Dep. CFSTI.

The distributions of fragments in mass and kinetic energies in the fission of ^{239}U induced by neutrons with energies of 1.4, 1.6, 1.9, 5.0, 5.5, and 6.9 MeV are investigated. The results of the measurements are analyzed in the framework of a statistical model. A correlation of the fission-yield fine structure is discussed with a dependence curve of maximum fission energy on the mode of fission. It is found that the mean kinetic energy of fragments practically does not depend on the energy of neutrons which induce a fission. (auth)

42019 (MLM-1494) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT, JANUARY-MARCH 1968. (Mound Lab., Miamisburg, Ohio). Mar. 29, 1968. Contract AT-33-1-GEN-53. 42p. Dep. CFSTI.

Research progress is reported on: the $\alpha-\beta$ branching ratio of ^{227}Ac, neodymium preparation, characterization of heavy-metal-inorganic ion exchange systems, ^{234}U recovery, ^{229}Th recovery, ^{206}Pb recovery, decay scheme of ^{210m}Bi, internal conversion electron and gamma transitions in ^{227}Ac, excited states of ^{21}Na, neutron total cross section for ^{16}O, and reworking of a lithium-drifted germanium detector. (M.C.G.)

42020 (N-68-11074) SCATTERING OF 42-MeV (6.7-PJ) ALPHA PARTICLES FROM EVEN ISOTOPES OF CADMIUM. Baron, Norton; Leonard, Regis F.; Stewart, William M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1967. 19p. (NASA-TN-D-4256). CFSTI.

Angular distributions were measured for the elastic and inelastic scattering of 42 MeV (6.7-pJ) alpha particles from isotopically enriched targets of ^{110}Cd, ^{112}Cd, ^{114}Cd, and ^{116}Cd. In each isotope, five excited states were seen and their excitation energies were determined to ±30 keV (±4.8 fJ). Angular distributions for three of these states were measured over the angular range 30° to 65°. Their relative phases and excitation energies indicate that these states are the first 2^+, the 3^-, and the two phonon 2^+. It is suggested that the two other excited states result from a quadrupole-octupole two-phonon transition. A tentative spin assignment of 5^- was made for one of them. Elastic angular distributions were analyzed using the optical model with a four-parameter Woods-Saxon potential. Excellent fits were obtained for the elastic scattering. Inelastic scattering was analyzed using a distorted-wave Born approximation calculation. These calculated inelastic angular distributions agree very well with the experimentally measured cross sections for scattering to one phonon states, and allow determination of deformation parameters which are in satisfactory agreement with those obtained elsewhere. (auth) (STAR)

42021 (UUIP-573) A SEARCH FOR AFTEREFFECTS OF THE ^{111}In ELECTRON CAPTURE DECAY ON THE ^{111}Cd $\gamma-\gamma$ CORRELATION. Falk, Fredrik; Linnfors, Alf; Thun, John Erik (Uppsala Univ. (Sweden). Inst. of Physics). Feb. 1968. 22p. Dep.

Aftereffects and their detection are discussed briefly. Three indium compounds (In_2O_3, In_2S_3, and $In(C_9H_7NO)_3$) were examined for evidence of aftereffects on the 173-247 keV $\gamma-\gamma$ correlation of the ^{111}In electron capture decay. The main experimental method was the application of a 23 kG decoupling magnetic field. The source temperature was also changed. No aftereffects were found, although the correlation in the third case seems to be attenuated below the hard core value. (Sweden)

42022 (UUIP-577) A DIRECTIONAL CORRELATION STUDY OF INTERBAND TRANSITIONS IN ^{172}Yb. Vukanovic, R.; Zupancic, M.; Lindstroem, H. A.; Samuelsson, L. (Uppsala Univ. (Sweden). Inst. of Physics). Apr. 1968. 34p. Dep.

The $\Delta K = 3$ transitions de-exciting the K = 3 rotational band based on the 1172-keV state in ^{172}Yb were studied by $\gamma-e^-$ and e^--e^- directional correlations. The E2/M1 mixing ratios for the 912-, 1003-, 1093-, and 1115-keV transitions were determined and were compared with theoretical predictions. The conversion coefficient of the 912-keV transition was obtained as well as the total K particle parameters for the 912- and 1093-keV transitions. The half-life of the 1172-keV state was found to be $T_{\frac{1}{2}} = 7.95$ nsec. (Sweden).

42023 (UUIP-590) INTERNAL CONVERSION STUDIES OF THE 113-keV TRANSITION IN ^{177}Hf. Toernkvist, S.; Stroem, S.; Thun, J. E.; Schmidt, V.; Baade, N. (Uppsala Univ. (Sweden). Inst. of Physics). May 1968. 15p. Dep.

The multipole mixing of the 113-keV transition in ^{177}Hf was studied by measuring the directional correlations involving K, L_{II}, and L_{III} electrons, and by determining the K-conversion coefficient. All data are consistent giving $\delta = -3.1 \pm 0.6$. (auth) (Sweden)

42024 K-X-RAY-γ-RAY DIRECTIONAL CORRELATION IN THE DECAY OF ^{133}Ba. McDonnell, Michael; Ramaswamy, M. K. (Fordham Univ., Bronx, N. Y.). Phys. Rev., 171: 1278-9(July 20, 1968).

In view of recent work of Perepelkin on ^{54}Mn, in which he finds a definite correlation between the K x ray following K capture and the succeeding γ ray, the directional correlation between K x rays following allowed K capture and the succeeding (303 + 356) γ rays in the decay of ^{133}Ba was measured. The results can be expressed as $W(\theta) = 1 + (0.003 \pm 0.004)P_2(\cos\theta)$, with an anisotropy of 0.005 ± 0.006. These results imply little or no correlation and are consistent with Dolginov's theory. (auth)

42025 LIFETIME OF THE 603-keV LEVEL OF ^{124}Te. Schumacher, M. (Bartol Research Foundation, Swarthmore, Pa.). Contract AT(30-1)-3525. Phys. Rev., 171: 1279-82 (July 20, 1968). (NYO-3525-28).

A modified centrifuge technique using a rotating scatterer in addition to a rotating source was used to measure the lifetime of the 603-keV level of ^{124}Te. This method yields a considerable improvement of the overlap of emission and absorption lines compared with a single-rotor arrangement if γ rays from a ^{124}Sb source are used to excite the 603-keV level in ^{124}Te. In order to check the reliability of this method, a single rotor lifetime measurement was also carried out, the result of which agreed very well with the result of the double-rotor measurement. The weighted average of both values for the mean lifetime of the 603-keV level in ^{124}Te is $\tau = 9.5 \pm 0.5 \times 10^{-12}$. (auth)

42026 HIGH-RESOLUTION GAMMA-RAY SPECTROSCOPIC STUDIES OF THE DECAYS OF 2.6-hr Nd^{141g} AND 60-sec Nd^{141m}. Beery, D. B.; Kelley, W. H.; McHarris, Wm. C. (Michigan State Univ., East Lansing). Phys. Rev., 171: 1283-9(July 20, 1968).

Gamma rays emitted in the decays of 2.6-h ^{141g}Nd and 60-sec ^{141m}Nd were investigated with Ge(Li) and NaI(Tl) detectors. Following the decay of ^{141g}Nd, γ rays with the following energies (and relative intensities) were observed: 145.4 (30.0), 981.3 (3.0), 1126.8 (≡100), 1147.1 (38.2), 1292.8 (61.2), 1298.7 (16.3), 1434.6 (3.0), 1579.9 (0.74), 1607.9 (2.3), and 1657.2 keV (0.12). On the basis of coincidence and anticoincidence experiments, energy sums, and relative intensities, states were placed in ^{141}Pr at 0, 145.4, 1126.8, 1292.5, 1298.4, 1580.0, 1607.9, and 1657.2 keV. An upper limit of 0.1% of the intensity of the ^{141m}Nd 756.5-keV isomeric-transition γ ray was placed on the intensity of any other γ ray between 130 and 2600 keV following direct transitions from the $^{11}/_2-$ ^{141m}Nd to high-spin states of ^{141}Pr. Limits are placed on the spins of ^{141}Pr states on the basis of log ft values and relative photon intensities, and the structures of the states are discussed in terms of current nuclear models. (auth)

42027 DECAY OF ^{163}Ho. Hopke, P. K.; Evans, J. S.; Naumann, R. A. (Princeton Univ., N. J.). Phys. Rev., 171: 1290-2(July 20, 1963).

A sample of ^{163}Ho was prepared by neutron irradiation of ^{162}Er followed by chemical purification and isotope separation. This nuclide ^{163}Ho appears to decay by electron capture from the M and higher shells. A half-life of 33 ± 23 yr was estimated by counting the M Auger electrons and M x rays from a sample over a period of two years. A search for L x rays has been made. The M-to-L capture ratio is greater than 1040. From this datum the Q-value for electron capture can be deduced to be 9.1 ± 1.5 keV. (auth)

42028 LIFETIME OF THE EXCITED STATE AT 472 keV IN ^{43}Sc. Merdinger, J. C. (Institut de Recherches Nucleaires, Strasbourg); Schulz, N.; Kavanagh, R. W. Nucl. Phys., A115: 204-6(1968). (In French).

The mean life of the 472-keV excited state of ^{43}Sc was measured by a particle-gamma coincidence technique. The value obtained, $\tau = 227 \pm 19$ ps, indicates collective effects in ^{43}Sc. (auth)

42029 STRUCTURE OF THE FISSION TRANSITION NUCLEUS ^{236}U. Behkami, A. N. (Northwestern Univ., Evanston, Ill. Argonne National Lab., Ill.); Roberts, J. H.; Loveland, W.; Huizenga, J. R. Phys. Rev., 171: 1267-77(July 20, 1968).

Fission-fragment angular distributions for the ^{234}U (n,f) reaction were measured for incident neutron energies of 200, 300, 400, 500, 600, 700, 843, 998, and 1184 keV. A novel 2π geometry Lexan (polycarbonate) detector was used to detect the fission fragments. The angular distributions show intermediate-angle peaks and change shape rapidly with changes in neutron energy. Based on a

sophisticated Hauser-Feshbach analysis, which includes level-width fluctuation corrections of the energy variation of the fission cross section and angular distributions, a description of the highly deformed fission transition nucleus ^{235}U is given. Assignments of the quantum numbers (K,π) are made for three low-energy single-particle states, and they are $1/2^+$, $3/2^+$, and $3/2^-$. In addition, the presence of another $K = 1/2$ state is demonstrated. Assignments of the energy E and the barrier curvature $\hbar\omega$ of these states are also given. (auth)

42030 CORE EXCITATIONS IN ^{107}Ag, ^{109}Ag, ^{113}In, ^{115}In, ^{121}Sb, AND ^{123}Sb RESULTING FROM INELASTIC SCATTERING OF 42-MeV ALPHA PARTICLES. Stewart, W. M.; Baron, N.; Leonard, R. F. (Lewis Research Center, Cleveland). Phys. Rev., 171: 1316-24(July 20, 1968).

Alpha particles of 42-MeV energy were elastically and inelastically scattered from isotopically enriched targets of ^{113}In, ^{115}In, ^{107}Ag, ^{109}Ag, ^{121}Sb, and ^{123}Sb. Angular distributions were measured for a number of states in each isotope for angles between 30 and 80°. The results are compared with the predictions of the simple excited-core model with respect to the strengths and energies of the excitations. In all six isotopes, states were found which accounted for all of the one-quadrupole-phonon vibrational strength observed in the neighboring even–even nuclei. In ^{113}In, ^{115}In, and ^{121}Sb, multiplets of states were seen which contained all of the strength of the octupole vibrational states of the even neighbors. In ^{107}Ag and ^{109}Ag, only half of the expected octupole strength was observed. In both silver isotopes, a number of states were seen which have approximately the proper strengths and excitation energies to arise from the coupling of the odd proton to a two-phonon vibrational state of the core. (auth)

42031 ALPHA DECAY OF ^{243}Am. Van Hise, J. R.; Engelkemeir, D. (Argonne National Lab., Ill.). Phys. Rev., 171: 1325-30(July 20, 1968).

The decay of ^{243}Am was studied by observing $\alpha-\gamma$ coincidences using Si(Au) surface-barrier and Ge(Li) detectors in conjunction with a 4096-channel two-parameter analyzer. γ rays of 31.2, 43.6, 50.6, 55.4, 74.8, 86.7, 117.8, 142.0, 169, 195, and 220 keV were observed. Only the 43.6-, 74.8-, and 117.8-keV γ rays have been previously reported. These results confirm many features of the previously accepted level scheme of the ^{239}Np daughter. Furthermore, new levels at 72 and 123 keV have been found which are apparently the $9/2^+$ and $11/2^+$ members, respectively, of the ground-state rotational band. These energies agree well with predictions based on the collective model. The intensity ratio of α groups to the ground and first excited states have been measured to be 1.17, in poor agreement with a theoretical estimate of 2.03. (auth)

42032 PRODUCTION OF ^{7}Be, ^{22}Na, AND ^{24}Na FRAGMENTS FROM HEAVY ELEMENTS AT 3, 10, AND 30 GeV. Hudis, J.; Tanaka, S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 171: 1297-1300(July 20, 1968). (BNL-12057).

Formation cross sections of ^{7}Be, ^{22}Na, and ^{24}Na from tantalum, lead, and uranium targets irradiated with 3-, 10-, and 30-GeV protons were measured. Similar measurements were made with silver and gold targets at 30 GeV. At 10 and 30 GeV, the yield of ^{24}Na increases regularly with target mass, whereas at lower energies plots of cross section versus target mass show minima. From the ^{7}Be data, it seems probable that the excitation energy transferred to the struck nucleus by the incident particle reaches a maximum even for the heaviest nuclei at $E_p \leq 10$ GeV. Very little, if any, additional nuclear excitation energy is gained by raising the incident proton energy above this figure. (auth)

42033 PRODUCTION OF NEON-24 AND SODIUM-24 IN THE 1- TO 3-GeV PROTON BOMBARDMENT OF COPPER, SILVER, GOLD, AND URANIUM TARGETS. Hudis, J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 171: 1301-4(July 20, 1968). (BNL-12156).

Ratios of the cumulative yields of ^{24}Ne to the independent yields of ^{24}Na were measured from Cu, Ag, Au, and U targets irradiated with 1-, 2-, and 3-GeV protons. The ratios are essentially energy-independent for each target, although the cross-section values themselves increase by factors up to 10 between 1 and 3 GeV. The ratios increase with the N/Z ratio of the target from 0.04 for Cu to 0.4 for U at 2 and 3 GeV. These results combined with previously published data show that from all targets the maxima of the isobaric yield distribution for the mass-24 chain lie on or slightly to the neutron-rich side of the stability line. The peak of the isobaric distribution shifts slowly towards higher neutron/proton ratios as the mass of the target increases. (auth)

42034 LEVELS OF ^{209}Bi OBSERVED IN THE ^{208}Pb(^{3}He,d) REACTION. Bardwick, John; Tickle, Robert (Univ. of Michigan, Ann Arbor). Phys. Rev., 171: 1305-7(July 20, 1968).

The level structure of ^{209}Bi was studied using the ^{208}Pb(^{3}He,d)^{209}Bi reaction at 44.2 MeV. A distorted-wave-approximation analysis of angular distributions for the seven strong levels observed indicates that the following levels contain almost the full shell-model strength: g.s., $1h_{9/2}$; 0.90 MeV, $2f_{7/2}$; 1.61 MeV, $1i_{13/2}$; 2.83 MeV, $2f_{5/2}$; and 3.12 MeV, $3p_{3/2}$. The level at 3.64 MeV contains about two-thirds of the $3p_{1/2}$ strength. Our analysis did not provide a conclusive explanation for the level at 4.42 MeV. Angular distributions were also measured for three states weakly excited at 2.61, 4.52, and 4.58 MeV. A number of other states were weakly excited in the region between 3.4 and 4.4 MeV. (auth)

42035 TWO-NEUTRON-HOLE CONFIGURATIONS IN ^{206}Pb FROM ISOBARIC ANALOG MEASUREMENTS. Richard, Patrick (Univ. of Washington, Seattle); Stein, Nelson; Kavaloski, C. D.; Lilley, J. S. Phys. Rev., 171: 1308-11(July 20, 1968).

Two-neutron-hole configurations involving $p_{1/2}$, $f_{5/2}$, and $p_{3/2}$ neutrons are obtained for low-lying states of ^{206}Pb from proton elastic and inelastic scattering from the isobaric analog states (IAS) of ^{207}Pb. Excitation functions for inelastic scattering to four of the final states have very little off-resonance cross section and resonate at only one or two of the ^{207}Bi analog resonances, which is characteristic of the simple two-neutron-hole structure of the states. Experimental widths for decay from the IAS of the ^{208}Pb ground state to the first three hole states of ^{207}Pb are used to obtain the model widths needed to analyze the data. The two-neutron-hole configurations obtained for the ^{206}Pb wave functions compare very well with the recent shell-model calculations of True. (auth)

42036 p-WAVE RESONANCES OF ^{238}U. Bollinger, L. M.; Thomas, G. E. (Argonne National Lab., Ill.). Phys. Rev., 171: 1293-7(July 20, 1968).

The neutron transmission of a thick sample of ^{238}U was measured over the energy range 0 to 200 eV with exceptionally good statistical accuracy. The extremely small transmission dips that are detected are interpreted as p-wave resonances, and their resonance parameters are derived. The probability argument used to identify the p-wave resonances is applicable to most nuclides. (auth)

42037 ENERGY DISTRIBUTION OF LONG-RANGE α PARTICLES EMITTED DURING THE THERMAL NEUTRON FISSION OF ^{235}U. Sowinski, M.; Chwaszczewska, J.; Dakowski, M.; Gadomskŕ, A.; Krogulski, T.; Piasecki, E.; Piekarz, H. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol., 33: 819-25 (May 1968).

The energy spectrum of the long-range α particles emitted in the thermal neutron fission process of ^{235}U was measured. A good fit was found using the Gaussian distribution. The relative cross section (Y_{th}/Y_{res}) for thermal and resonance neutrons was determined. An attempt to estimate the yields of the other charged particles emitted in the ternary fission was made. (auth)

42038 M2 ISOMER IN ^{199}Au. Borggreen, J.; Naumann, R. A. (Univ. of Copenhagen). Nucl. Phys., A115: 14-16(1968).

The half-life of the 55-keV M2 transition in ^{199}Au was determined to be $T_{1/2} = 0.44 \pm 0.03$ ms. The radiative lifetime concerning possible E3 admixture is discussed. (auth)

42039 POLARIZATION MEASUREMENTS NEAR ISOBARIC ANALOGUE RESONANCES IN ^{139}La AND ^{141}Pr. Veeser, L.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys., A115: 172-84(1968).

The polarization of protons elastically scattered from barium and cerium was measured to determine the total angular momenta J of the isobaric analogues of the ground state and of four excited states of ^{139}Ba and of ^{141}Ce. Measurements were made in energy steps of 25 to 100 keV for proton energies in the region of 9 to 12 MeV. The angular momenta of the five levels studied were found to be $J^\pi = 7/2^-$, $3/2^-$, $1/2^-$, $5/2^-$, and $5/2^-$. The assignment of $J^\pi = 1/2^-$ for the second excited state is in disagreement with previous assignments. (auth)

42040 POLARIZATION MEASUREMENTS NEAR ISOBARIC ANALOGUE RESONANCES IN ^{117}Sb, ^{119}Sb, AND ^{121}Sb. Veeser, L.; Ellis, J. (Univ. of Wisconsin, Madison). Nucl. Phys., A115: 185-92(1968).

The polarization of protons elastically scattered from targets of ^{116}Sn, ^{118}Sn and ^{120}Sn was measured to determine the total angular momenta J of the isobaric analogues of the ground state and several low-lying excited states of ^{117}Sn, ^{119}Sn and ^{121}Sn. Measurements were made in energy steps of 25 to 200 keV for protons in the energy region of 7 to 9 MeV. (auth)

42041 DECAY OF ^{165}Yb. Tamura, Tsutomu (Japan Atomic Energy Research Inst., Tokyo). Nucl. Phys., A115: 193-203 (1968).

The decay properties of ^{165}Yb were studied by the use of scin-

tillation counters and germanium and silicon solid-state detectors. From the allowed unhindered nature of the β-transition (log ft = 4.7), the ground state of ^{165}Yb and the associated excited state of ^{165}Tm were assigned to the Nilsson orbitals $5/2^-(523)$ and $7/2^-(523)$, respectively. The $7/2^-(523)$ state of ^{165}Tm decays with E1 transitions of 80.2 and 30.5 MeV to the $7/2^+(404)$ intrinsic state and the $7/2$ or $5/2$ rotational member of the $1/2^+(411)$ ground state. The $7/2^+(404)$ state decays with the E2 transition of 68.7 keV to the $3/2$ rotational member of the $1/2^+(411)$ state. The lifetime of the $7/2^-(523)$ state was determined to be 9.0 ± 0.5 μsec, and the absolute γ-transition probabilities are discussed in the framework of the Nilsson model. (auth)

42042 COULOMB EXCITATION OF ^{235}U. Stephens, F. S.; Holtz, M. D.; Diamond, R. M.; Newton, J. O. (Univ. of California, Berkeley). Nucl. Phys., A115: 129-56(1968).

The Coulomb excitation of ^{235}U was studied using ^{4}He, ^{16}O, and ^{40}Ar projectiles. Rotational bands at 921 keV and 638 keV (tentative) were characterized as the $K_0 + 2$ and $K_0 - 2$ γ-vibrational bands, respectively, and a somewhat tentative band at 1053 keV was assigned as the β-vibrational band based on the ground state. Two bands at 633 and 822 keV are identified as the $5/2^-[752]$ and $5/2^-[734]$ Nilsson states, respectively. The large B(E2) value for exciting these bands indicates that they are strongly Coriolis coupled to the ground state band, $7/2^-[743]$. A three-parameter Coriolis calculation, involving all eight components of the $j_{15/2}$ shell-model orbital, can account adequately for all the rotational energies and transition probabilities observed in these three bands. (auth)

42043 GROUND STATE PARITY OF ^{227}Ac. Hagee, G. R. (Mound Lab., Miamisburg, Ohio); Lange, R. C.; Barnett, A. G.; Campbell, A. R.; Cothern, C. R.; Griffing, D. F.; Hennecke, H. J. Contract AT(33-1)-Gen-53. Nucl. Phys., A115: 157-60(1968).

The K-shell internal conversion coefficient and L-subshell electron ratios were measured for the transition from the $3/2^-$ 327-keV level to the $I = 3/2$ ground state in the ^{227}Ac. The results indicate that the transition is an M1 + E2 multipole mixture. Thus, the ^{227}Ac ground-state parity is odd. (auth)

42044 DECAY OF THE 32 msec ISOMER OF ^{194m}Ir. Heiser, C.; Brinckmann, H. F.; Fromm, W. D. (Zentralinstitut fuer Kernforschung, Dresden). Nucl. Phys., A115: 213-18(1968). (In German).

The gamma-ray spectrum of the 32-msec isomer in ^{194}Ir, excited by thermal neutron capture, was reinvestigated with a Ge(Li) spectrometer. Two gamma lines with energies of 111.0 keV ($I_\gamma = 1$) and 83.5 keV ($I_\gamma = 0.63$) and the x-ray peaks ($I_x = 7.7$) were observed. From the intensities and theoretical conversion coefficients for the 111-keV and the 83.5-keV gamma rays, a cascade of two M1 transitions or a cascade of transitions with the multipole order (E1 + M2) and M1 is indicated. Similar experimental results were recently published by Lundan and Siivola but their conclusions are quite different from the interpretation of the isomeric decay given here. (auth)

42045 EVIDENCE FOR j-FORBIDDEN ISOMERIC TRANSITION IN ^{208}Bi. Bonitz, M.; Kantele, J.; Sigurd Hansen, N. J. (Univ. of Copenhagen). Nucl. Phys., A115: 219-24(1968).

The decay scheme of the 2.5-ms isomeric state in ^{208}Bi was established with the aid of high-resolution γ-ray and electron spectrometry. The multipolarity of the 921.0 keV isomeric transition was determined as E3 and the 1571.1-keV isomeric state therefore probably has spin and parity 10^-. The isomeric transition is hindered by a factor of 3.200 with respect to the Weisskopf estimate. This can be explained as being due to j-forbiddeness. (auth)

42046 NUCLEAR DECAY PROPERTIES OF ^{256}Fm. Hoff, R. W.; Evans, J. E.; Hulet, E. K.; Dupzyk, R. J.; Qualheim, B. J. (Univ. of California, Livermore). Nucl. Phys., A115: 225-33 (1968).

The nuclide ^{256}Fm was produced in ^{4}He ion bombardment of a 3 μg ^{253}Es target. With samples where the fermium fraction was isolated chemically, the mass 256 was enriched in an electromagnetic isotope separator. The nuclear decay properties of ^{256}Fm were measured as follows: the half-life is 157 ± 2 min. The alpha branching ratio is $\alpha/(\alpha + SF) = 0.081 \pm 0.003$, and the alpha-particle energy of the most abundant group is 6.925 ± 0.005 MeV. The measured alpha-decay rate shows satisfactory agreement with a calculated value derived from theory. The cross section for the reaction ^{255}Fm(n,γ)^{256}Fm with well-moderated reactor neutrons was measured and was found to be 30 ± 4 b. (auth)

42047 HIGH-SPIN ISOMER ^{194m}Ir PRODUCED BY TRIPLE NEUTRON CAPTURE. Sunyar, A. W.; Scharff-Goldhaber, G.; McKeown, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 21: 237-40(July 22, 1968).

A 171-day high-spin ($I \geq 10$) isomer was discovered in ^{194}Ir. It is predominantly formed by three successive neutron captures from ^{191}Ir, via successively higher spin states in ^{192}Ir ($I = 4$) and ^{193m}Ir ($I = 11/2$). The isomer decay by γ decay chiefly to a 2438-keV state in ^{194}Pt, which is depopulated by two parallel branches. The more intense branch proceeds through a "ground-state band" ($8^+ \rightarrow 6^+ \rightarrow 4^+ \rightarrow 2^+ \rightarrow 0^+$) whose level energies indicate that ^{194}Pt is a somewhat deformed and very "soft" nucleus. (auth)

42048 (p,p'n), (p,p'γ), AND (p,np') REACTIONS ON ^{119}Sn AND ^{61}Ni. Cohen, B. L.; May, E. C.; O'Keefe, T. M.; Fink, C. L.; Rosner, B. (Univ. of Pittsburgh). Phys. Rev. Lett., 21: 226-9(July 22, 1968).

The Weisskopf–Ewing assumption that an (x,yn) reaction occurs with nearly unit probability if the first emitted particle, y, comes off with sufficiently low energy to make neutron emission energetically possible was tested by coincidence studies of (p,p'n) and (p,p'γ) reactions on ^{119}Sn and ^{61}Ni and found to be grossly in error. In particular, (p,p'γ) competes favorably with (p,p'n) even when neutron emission is energetically possible by ~2 MeV. In ^{119}Sn, the detailed shape of the energy spectrum of neutrons implies that spectra are drastically non-Maxwellian at low energies. (auth)

42049 NUCLEAR SPECTROSCOPY WITH AVERAGE SPECTRA FROM NEUTRON RESONANCE CAPTURE. Bollinger, L. M.; Thomas, G. E. (Argonne National Lab., Ill.). Phys. Rev. Lett., 21: 233-7(July 22, 1968).

Methods for the determination of spins and parities of nuclear states by means of measurements of the average γ-ray spectra formed by neutron capture in many resonances are described. Results for 30 low-energy states of ^{168}Er illustrate the use of the average γ-ray intensity, and measurements on nuclides near $A = 100$ show that the γ-ray line shape can also provide valuable information. (auth)

42050 Ge(Li)–Ge(Li) COINCIDENCE STUDIES OF THE DECAY OF ^{109}Pd. Berzins, G.; Bunker, M. E.; Starner, J. W. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A114: 512-28 (1968).

The energy levels of ^{109}Ag that are populated in the decay of 13-h ^{109}Pd were investigated with high-resolution Ge(Li) gamma-ray spectrometers. Coincidence results obtained with a Ge(Li)–Ge(Li) detector system coupled with energy sums and relative intensity considerations suggest the existence of excited states in ^{109}Ag at 88, 133, 311, 415, 702, 724, 735, 863, 869, 911, 912, and 1099 keV. An additional state is present at either 707 or 795 keV. A comparison with previous Coulomb excitation data was made. Spin and parity assignments are suggested for most of the states, and the level structure is discussed in terms of existing nuclear models. (auth)

42051 THE LEVEL SCHEME OF ^{171}Tm. Raeside, D. E.; Reidy, J. J.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A114: 529-40(1968).

The gamma-ray spectrum associated with the decay of ^{171}Er was studied with curved-crystal and Ge(Li) spectrometers. The data provide energy and intensity measurements of 40 gamma rays. A previously unreported weak 694-keV transition which appears to belong to the decay of ^{171}Er was measured. Previously reported transitions at 166, 404, 573, and 842 keV were not observed. Coincidence spectra show that the 372-keV transition feeds the 913-keV level. The absence of transitions at 166 keV and 404 keV together with the new placement of the 372-keV transition place the existence of a previously proposed 591-keV level in doubt. A recently proposed level at 489 keV is not supported by the energy measurements and coincidence data. The new placement of the 372-keV transition suggests a new level at 1285 keV. (auth)

42052 THE LOW-ENERGY LEVELS OF ^{211}Bi. Hamilton, W. D.; Davies, K. E. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A114: 577-88(1968).

The gamma-ray spectrum of the excited levels of ^{211}Bi populated following the β decay of ^{211}Pb was examined using both NaI(Tl) and germanium detectors. Coincidence, component sum coincidence and sum coincidence techniques were used to evaluate the spectra and the possible cascades which occur. Evidence is presented for several new transitions and the results of previous work are largely confirmed with respect to the decay scheme. There are, however, some disagreements with previous measurements of the γ-decay relative intensities. In particular the 405 : 427-keV intensity is $1 : 0.40 \pm 0.03$ and together with the relative intensities of K-shell conversion electrons implies that the 427-keV transition is essentially pure M1. The conversion coefficients for other dominant transitions are evaluated. (auth)

42053 SPIN ASSIGNMENTS AND MULTIPOLE MIXING RATIOS IN ^{211}Bi. Davies, K. E.; Hamilton, W. D. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A114: 589-601(1968).

The spins of the 405-, 832-, and 1106-keV excited states in ^{211}Bi and the multipole mixing ratios of the cascade transitions which link them with the ground state were determined from γ-γ and γ-linear polarization γ-angular correlation measurements. The level spins were uniquely determined, and the results for the multipole mixing ratios are given. This set of results is consistent with internal conversion coefficient measurements. These results also support recent theoretical calculations of the level scheme by Gabrakov. (auth)

42054 THE DECAY OF ^{180}Os. Konijn, J.; Goudsmit, P. F. A.; De Boer, F. W. N.; Meijer, B. J. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A114: 602-8(1968).

The decay of 25.5 ± 0.4 min ^{180}Os occurs by a fast beta transition (log ft = 4.7) followed by a 20.1-keV E1 gamma-ray transition; the intermediate level has a half-life of 87.5 ± 2.7 nsec. These results are interpreted in terms of the Nilsson model. (auth)

42055 CONVERSION-ELECTRON PARTICLE PARAMETERS OF E2 TRANSITIONS IN RARE-EARTH NUCLEI. Zganjar, E. F.; George, T. M.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Nucl. Phys., A114: 609-22(1968).

The conversion-electron particle parameters b_2 were determined for several E2 transitions in the deformed nuclei ^{152}Sm and ^{154}Gd and the spherical nucleus ^{152}Gd. The b_2 values were obtained from e^--γ and γ-γ directional correlation studies in which both correlations were measured with the same source for a given transition. The three measured particle parameters for the 122- and 123-keV transitions are about 13 ± 9%, 25 ± 4%, and 30 ± 10% lower than theory; that of the 245-keV transition is 38 ± 9%, lower than theory; and that of the 344-keV transitions agrees with theory (1 ± 11% low). (auth)

42056 E0/E2 MIXING RATIO FOR TRANSITIONS FROM BETA VIBRATIONAL STATES IN DEFORMED NUCLEI WITH UNEVEN NUCLEON NUMBERS. Winter, Georg; Sodan, Horst (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A114: 629-35(1968). (In German).

Using the wave functions of Soloviev for deformed odd-mass nuclei, the E0/E2 mixing ratio was calculated for transitions from both beta vibrational states to corresponding single-particle states. The results of this calculation were used to derive the internal conversion coefficients of mixed transitions. These values are compared with experimental results. (auth)

42057 DECAY OF AN ISOMERIC STATE IN ^{178}Hf WITH K ≥ 16. Helmer, R. G.; Reich, C. W. (Idaho Nuclear Corp., Idaho Falls). Nucl. Phys., A114: 649-62(1968).

A long-lived isomeric activity in ^{178}Hf was produced by neutron irradiation of hafnium. The isomeric state occurs at an energy of ≈2.5 MeV and has a half-life >10 yr. The gamma-ray transitions associated with the decay of the isomer were studied by means of a Ge(Li) spectrometer and a NaI(Tl) gamma-gamma coincidence system. The resulting decay scheme includes the following known levels of the $K^\pi = 0^+$ ground-state rotational band: 93.181 (I = 2), 306.625 (4), 632.19 (6), and 1058.56 keV (8). This scheme also includes the previously reported $K^\pi = 8^-$ level at 1147.44 keV along with the following members of its rotational band: 1364.11 (I = 9), 1601.50 (10), 1859.12 (11), 2136.50 (12), and 2433.32 keV (13). The M1 transition probabilities of these intraband transitions were obtained from the observed gamma-ray intensities assuming the validity of the Alaga rules for the rotational E2 transitions. These probabilities provide an estimate of the amount of mixing between this band and that built on the $K^\pi = 8^-$ state at 1480 keV. Although a configuration assignment for the isomeric state cannot be made with certainty on the basis of the present data, the most plausible interpretation is that it is a four-quasi-particle state with $K^\pi = 16^+$. (auth)

42058 ISOMERIC CROSS-SECTION RATIOS FOR SOME REACTIONS INDUCED BY 14.8-MeV NEUTRONS IN Te ISOTOPES. Husain, L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3235. Nucl. Phys., A114: 663-72 (1968). (ORO-3235-32).

Fast neutron cross sections of tellurium were measured using natural and enriched tellurium isotopes. A 7.6 × 7.6 cm NaI(Tl) detector was used for the radioactivity measurements and radiochemical separations were used in some cases. The cross sections measured are: ^{120}Te(n,2n)^{119m}Te, 535 ± 85 mb; ^{120}Te(n,2n)^{119g}Te, 685 ± 100 mb; ^{122}Te(n,2n)^{121m}Te, 530 ± 80 mb; ^{122}Te(n,2n)^{121g}Te, 750 ± 100 mb; ^{128}Te(n,2n)^{127g}Te, 760 ± 100 mb; ^{130}Te(n,2n)^{129m}Te, 241 ± 30 mb; ^{130}Te(n,2n)^{129g}Te, 435 ± 50 mb; ^{120}Te(n,p)^{120m}Sb, 1.5 ± 0.2 mb; ^{120}Te(n,p)^{120m}Sb, 1.0 ± 0.1 mb; ^{120}Te(n,p)^{120g}Sb, 1.3 ± 0.3 mb; ^{124}(n,α)^{121g}Sn, 0.8 ± 0.1 mb; ^{128}Te(n,α)^{125m}Sn, 0.5 ± 0.1 mb. The results obtained are compared with the existing data, and semi-empirical predictions of Gardner. (auth)

42059 NATURE OF THE K = 2 STATES IN EVEN DEFORMED NUCLEI. Yamazaki, T.; Sakai, M.; Mikoshiba, O. (Tokyo Univ.). Nucl. Phys., A114: 641-8(1968).

A crucial test to discriminate between the Bohr-Mottelson model and the Davydov-Filippov model is proposed. The analysis of the beta transition rates from ^{186}Re and ^{188}Re to the K = 2 bands in ^{186}Os and ^{188}Os disfavors the asymmetric-rotor model. The beta transition rate to the K = 2 state is evaluated on basis of the microscopic description of the gamma vibration. Presently available data on M1 transitions from 1^+ states to the K = 2 bands in ^{156}Gd and ^{188}Os also disfavor the asymmetric-rotor model. (auth)

42060 DIRECTIONAL CORRELATION OF GAMMA RAYS IN THE DECAY OF 2.3-d ^{115}Cd. Bajaj, M. M.; Gupta, S. L.; Saha, N. K. (Univ. of Delhi). Aust. J. Phys., 21: 317-23 (June 1968).

The gamma-gamma directional correlation of the 35–493 keV cascade in the decay of 2.3-d ^{115}Cd was studied by the coincidence method. The results seem to favor the spin and parity assignments $\frac{1}{2}^+$, $\frac{3}{2}^+$, and $\frac{1}{2}^-$ for the levels at 864, 829, and 336 keV, respectively, and indicate that the 35-keV transition is (96.5 ± 0.5) % M1 and (3.5 ± 0.5) % E2, with a mixing parameter δ = −0.191 ± 0.014. These results agree with the recent internal conversion coefficient measurements of Bäcklin, Fogelberg, and Malmskog but differ from those of earlier work. Computation of the partial lifetimes of the 35-keV radiation on this basis indicates that the M1 transition is retarded by a factor of ≈23 and the E2 transition is enhanced by a factor of ≈958. The E1 component of 493-keV radiation is estimated to be hindered by a factor of ≈4 × 10^{-7}, while the M2 component is retarded by a factor of ≈3. The possible collective nature of the 829-keV level is discussed. (auth)

42061 PARTICLE-PLUS-CORE AND DOORWAY STATES IN ^{207}Pb. Auerbach, N.; Stein, N. (Yale Univ., New Haven). Phys. Lett., 27B: 122-6(June 24, 1968).

The particle-core coupling model is used to calculate the spreading of single-particle strength in ^{207}Pb based on coupling of single particles to the ground state and first excited state (2^+) of ^{206}Pb. The particle-plus-2^+-excited core states are interpreted as doorway states. (auth)

42062 METHOD FOR DIRECT OBSERVATION OF THE GIANT MAGNETIC FIELDS PRODUCED AT A NUCLEUS BY A HOLE IN THE K SHELL. Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 7: 280-4(May 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 357-9(May 5, 1968).

It is shown that the perturbation of angular correlations by the short-lived effect of the strong magnetic on a nucleus in the presence of a hole in the K-shell can be investigated quantitatively by comparing the γ-γ and e_k-γ (e_k is the internal conversion electron from the K-shell) angular correlations. (D.C.W.)

42063 LOW-ENERGY GAMMA RADIATION FROM ^{71}Ge. Maria, Henriette; Dalmasso, Josette (Faculte des Sciences, Nice). Compt. Rend., Ser. C, 267: 111-13(July 8, 1968). (In French).

Seventeen previously unreported gamma rays were observed in the low-energy spectrum of ^{71}Ge using a germanium n-i-p diode. (D.C.W.)

42064 AN INTERPRETATION OF THE STRUCTURE OF SUBTHRESHOLD FISSION CROSS SECTION OF ^{240}Pu. Weigmann, H. (EURATOM, Geel, Belgium). Z. Phys., 214: 7-15(1968).

The structure recently observed in the subthreshold fission cross section of ^{240}Pu is interpreted as being due to intermediate states of the fissioning nucleus associated with the second minimum of the potential energy as a function of deformation postulated by Strutinsky. (auth)

42065 DETERMINATION OF THE PRIMARY FISSION YIELDS OF ^{148m}Pm AND ^{148}Pm FROM THE THERMAL FISSION OF ^{235}U. Baechmann, K. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 9: 27-31(May 1968). (In German).

The determination of the fractional independent fission yields resulted in a value of 6.7×10^{-5} for ^{148m}Pm and an upper limit of 10^{-5} for ^{148}Pm. The value found for ^{148m}Pm is compatible with the curves of charge dispersion which were found out earlier. The ratio of the yields is discussed. (auth)

42066 LOW-ENERGY STRUCTURE STUDIES OF WEAKLY DEFORMED ODD–ODD NUCLEI: ^{186}Re AND ^{188}Re. Lanier, Robert

George. Tallahassee, Florida State Univ., 1968. 209p. Thesis.

Nuclear levels in ^{186}Re were investigated through the (d,p) and (d,t) reactions with 12-MeV deuterons and a broad-range magnetic spectrograph. The results of high-energy (n,γ) measurements and low-energy (n,γ) studies together with the charged particle reaction data have provided a great deal of information on the level structure of ^{186}Re. With the aid of (d,p) angular distributions, the Ritz combination principle applied to low-energy gamma transitions, and measured transition multipolarities, the energy levels up to an excitation energy of approximately 470 keV were interpreted in terms of the unified model. Six band heads resulting from the coupling of the proton orbital $5/2^+(402\uparrow)$ to the neutron orbitals $3/2^-(512\downarrow)$, $1/2^-(510\uparrow)$, and $7/2^-(503\uparrow)$ were identified. A possible proton excited state at 314 keV was tentatively classified as resulting from the configuration: $p^3/2^-(514\uparrow)$; $n^3/2^-(512\downarrow)$. Many higher-lying levels were also observed. A calculation including the effect of the Coriolis interaction was performed in an attempt to further understand the ^{186}Re level structure below 500 keV. Except for the ground-state rotational band, the predicted charged particle reaction cross sections are in general agreement with those observed. These calculations suggest that residual interaction effects may be severely distorting the simple two-particle Nilsson wave functions of low-lying configurations. The structure of ^{188}Re was investigated utilizing the (d,p) reaction. High- and low-energy (n,γ) data, together with the results of the (d,p) studies indicate that the level structure of ^{188}Re closely resembles that of ^{186}Re. Unfortunately, unambiguous assignments of spins and parities have proved difficult because of the lack of sufficient conversion electron data. (Disser. Abstr.)

42067 CONVERSION ELECTRON PARTICLE PARAMETERS IN THE DECAY OF ^{152}Eu AND ^{154}Eu. Nasir, Hanna Musa. Lafayette, Ind., Purdue Univ., 1967. 84p. Thesis.

The internal conversion electron particle parameters of several fast low-energy E2 transitions in the deformed nuclei ^{152}Sm and ^{154}Gd were determined by comparing the electron-gamma direction correlations and gamma-gamma directional correlations displayed by the same source. Special attention was paid to eliminate the effects of scattering in the source, and the corrections caused by the presence of extra-nuclear perturbations of the directional correlations were carefully studied. The results are: 0.122-MeV transition in ^{152}Sm: $b_2(E2,K) = 1.60 \pm 0.05$, $b_2(E2,L) = 1.03 \pm 0.05$; 0.245-MeV transition in ^{152}Sm: $b_2(E2,K) = 1.72 \pm 0.07$; 0.344-MeV transition in ^{152}Gd: $b_2(E2,K) = 1.57 \pm 0.13$; 0.123-MeV transition in ^{154}Gd: $b_2(E2,K) = 1.37 \pm 0.07$. The particle parameters of the 0.245-MeV and the 0.344-MeV transitions agree with the theoretical values within the experimental errors. The experimental particle parameters of the 0.122-MeV ground-state transitions in ^{152}Sm are about 15% lower than predicted by theory, and that of the 0.123-MeV ground-state transition in ^{154}Gd is 25% lower. Possible reasons for this discrepancy between theory and experiment is discussed in the text. (Disser. Abstr.)

42068 MEASUREMENTS OF SOME GAMMA-RAY RELATIVE INTENSITIES AND INTERNAL CONVERSION COEFFICIENTS USING A BENT-CRYSTAL MONOCHROMATOR. Nelson, Gerald Clifford. Ames, Iowa, Iowa State Univ., 1967. 164p. Thesis.

The x-ray and gamma-ray relative intensities were measured from the decay of ^{170}Tm, ^{166}Ho, ^{180m}Hf, ^{155}Eu and ^{155}Sm with a bent-crystal monochromator and a linear least-squares computer program. The K-shell internal conversion coefficients were determined for the E2 transitions in ^{170}Yb and ^{166}Er. The K-shell conversion coefficient, α_K, for the 84.3-keV transition in ^{170}Yb was determined to be 1.43 ± 0.04 while the K-shell internal conversion coefficient for the 80.6-keV transition in ^{166}Er was determined to be 1.72 ± 0.06. The results for these $2^+ \rightarrow 0^+$ transitions are five percent higher than the theoretical values for these transitions. From the relative intensities of the transitions in ^{180}Hf, it was possible to deduce a value for the total internal conversion coefficient for the 93.3-keV transition of $\alpha_T^{93} = 4.91 \pm 0.23$. Using the previous measurements of conversion electron intensities of Edwards and Boehm and the present measured gamma-ray relative intensities, internal conversion coefficients for all the other transitions were obtained. The present measurements of α_K for the 215.3-, 332.5- and 443.8-keV E2 transitions are eleven percent lower than the theoretical values, while α_K for the 93.3-keV E2 transition agrees closely with the theoretical value. These results are in close agreement with the previous measurements of Edwards and Boehm. The present value for α_K for the 501-keV transition agrees closely with the theoretical α_K for an E3 multipolarity. From the x-ray and gamma-ray relative intensities of the transitions in ^{155}Gd and the previous measurement of the ratio of K conversion electrons for the 86- and 105-keV transitions of Subba Rao, it was possible to determine the K conversion coefficients for the 86- and 105-keV transitions of $\alpha_K = 0.43 \pm 0.06$ and $\alpha_K = 0.23 \pm 0.03$. These results are in agreement with the theoretical values for pure E1 transitions. The relative intensities of the 246-, 142- and 104-keV gamma rays following the decay of 22-min ^{155}Sm were determined with improved precision in order that they might be used to determine accurately the conversion coefficients for these transitions. (Disser. Abstr.)

42069 POLARIZATION MEASUREMENTS NEAR ISOBARIC ANALOG RESONANCES IN HEAVY NUCLEI. Veeser, Lynn Raymond. Madison, Wis., Univ. of Wisconsin, 1968. 88p. Thesis.

The polarization of protons scattered elastically from several spin-zero targets was measured to determine the total angular momenta, J, of isobaric analog states in the compound nuclei. The polarization was measured at two or three scattering angles for each target. Measurements were made in energy steps of 25 to 200 keV. The targets and energy ranges are: ^{120}Sn (7.4 to 9.1 MeV), ^{122}Sn (6.5 to 9.5 MeV), ^{116}Sn (6.7 to 8.5 MeV), barium (9.6 to 12.0 MeV), and cerium (9.2 to 11.8 MeV). Previous assignments of the J-values for 19 levels were confirmed experimentally, and similar assignments for two other levels were found to be in error. The isobaric analogs of the second excited states of ^{139}Ba and ^{141}Ce were found to have $J^\pi = 1/2^-$ rather than $3/2^-$. Calculations were made of the polarization in the energy regions where measurements were taken. The off-resonance phase shifts were calculated from an optical model. Resonance parameters which had been found from earlier cross section measurements were used to determine the resonance phase shifts. Good agreement is found between the measurements and the calculations. (Disser. Abstr.)

42070 GAMMA–GAMMA ANGULAR CORRELATIONS OF THE RADIATIONS FROM THE DECAY OF ^{175}Hf. Singh, B. P.; Dahiya, H. S.; Pande, U. S. (Univ. of Roorkee, India). Progr. Theor. Phys. (Kyoto), 39: 1363-5(May 1968).

Angular correlation studies of the 89-343 and 161-343 keV cascades in the decay of ^{175}Hf were made. The results were used to make multipolarity assignments to transitions in ^{175}Lu. (D.C.W.)

42071 ANGULAR DISTRIBUTION OF GAMMA RAYS FROM INELASTIC NEUTRON SCATTERING NEAR THRESHOLD. Torop, Lee Walter. Stanford, Calif., Stanford Univ., 1967. 83p. Thesis.

The angular distributions of gamma rays following inelastic neutron scattering, near threshold, to the first excited states of the target nuclei were investigated experimentally and theoretically. Measurements were made using NaI(Tl) crystal detectors and natural targets of iron, cerium and bismuth. Data were obtained for the angular distribution of gamma rays following inelastic neutron scattering, by ^{56}Fe at the center-of-mass energies (of the target nucleus plus incident neutron system) E = 0.87, 0.90, 0.93, 0.95 and 0.99 MeV, by ^{140}Ce at E = 1.64, 1.67, 1.71, 1.75, and 1.87 MeV, and by ^{209}Bi at E = 1.04 MeV. The inelastic neutron scattering proceeds via compound-nucleus formation. At the excitation energies involved the compound-nuclear states are overlapping. The predictions for the gamma-ray angular distributions of the two following theories are determined: the Satchler–Sheldon theory, which is based on the application of the assumptions of the Hauser–Feshbach theory of inelastic neutron scattering to angular correlations in the (n,n′γ) process; and the more fundamental theory of Moldauer, specialized to the pure compound-nucleus process and employing the "uncorrelated amplitude" assumption. It is shown that near threshold the predictions of the two theories are nearly the same. Also, as much change is produced by using different sets of transmission coefficients as by the application of the two different theories. Theory and experiment are in good agreement for cerium at all energies at which angular distributions were obtained, and for iron at E = 0.99 MeV but not at lower energies. Two general conclusions are drawn about measurements of the angular distribution of gamma-rays following inelastic neutron scattering in medium and heavy nuclei at energies near threshold: such measurements are not useful in deciding between the theories of Satchler–Sheldon and Moldauer; but they provide data for a sensitive test of the Hauser–Feshbach statistical assumptions. (Disser. Abstr.)

42072 DIRECTIONAL CORRELATION MEASUREMENTS WITH L_I AND L_{II} CONVERSION ELECTRONS OF THE 31-keV TRANSITION IN ^{195}Pt. Toernkvist, S.; Thun, J. E.; Stroem, S.; Albridge, R. G.; Schmidt, V. (Univ. of Uppsala). Z. Phys., 214: 214-20 (1968).

The (31 L_I–99γ) and (31 L_{II}–99γ) directional correlations were measured in ^{195}Pt. The results give the mixing ratio for the 31-keV transition to be $\delta = 0.012 \pm 0.004$. (auth)

42073 ON THE ASYMMETRY OF THE REACTION $^{139}La(n,\alpha)^{136}Cs$ WITH POLARIZED NEUTRONS. Brendle, Martin (Univ., Tuebingen, Ger.). Z. Phys., 214: 127-35(1968). (In German).

The asymmetry of the reaction $^{139}La(n,\alpha)^{136}Cs$ with polarized 15.9-MeV neutrons was measured at an alpha-particle emission angle of 28° and alpha-particle energies greater than 17.3 MeV. From that the analyzing power of the reaction was found to be -0.5 ± 0.2. (auth)

42074 DETERMINATION OF THE NUCLEAR QUADRUPOLE MOMENTS OF THE TWO STABLE EUROPIUM ISOTOPES FROM THE Eu II SPECTRUM. Guthoehrlein, G. (Technische Univ., Hanover). Z. Phys., 214: 332-56(1968). (In German).

The hyperfine structure of the transitions $4f^7\ 6p\ ^9P_{3,4,5}-4f^7\ 6s\ ^9S_4$, $^7S_3$ in the spark spectrum of europium was investigated by a digital recording double Fabry–Perot spectrometer. Enriched samples of ^{151}Eu and ^{153}Eu were used in hollow cathode light sources cooled in liquid air. As the hyperfine splitting of the ^9P levels was not completely resolved the patterns were analyzed by a computer. The A- and B-values of the ^9P levels were determined for both isotopes. Together with the experimental A-values of the ^7P levels these A-values were used to check the eigenfunctions of Bordarier, Judd, and Klapisch, which have been calculated for intermediate coupling. Good agreement between observed and calculated A-values was reached only if the spherical-symmetric part of the magnetic hyperfine interaction operator of the 6p-electron was used as a free parameter. In this way the configuration interaction between $4f^7$ 6p and $4f^6$ 6s 6d can be taken into account. Fortunately this mixing does not affect the quadrupole interaction. Therefore the quadrupole moments were derived from the measured B-values using the unperturbed eigenfunctions. The results $Q(^{151}Eu) = 1.12 \pm 0.07 \times 10^{-24}$ cm^2 and $Q(^{153}Eu) = 2.85 \pm 0.18 \times 10^{-24}$ cm^2 are in complete agreement with the values obtained by Mueller, Steudel, and Walther in the $4f^7$ 6s 6p levels of the arc spectrum of europium. The values found for the hyperfine anomaly agree very well with the values derived from levels in Eu(I) and Eu(III). (auth)

42075 ELECTRON COINCIDENCE STUDIES IN RADIOACTIVE DECAY. Marelius, Anders. Abstracts of Uppsala Dissertations in Science. Uppsala, Univ. of Uppsala, 1968. 9p.

Thesis.

A review is given on 11 published papers on coincidence measurements and modifications of the instrumentation necessary for work in the low-energy region. The titles of the papers are: electrostatic preacceleration of electrons in a long magnetic spectrometer; an electron scintillation detector with good energy resolution; a fully automatized electron coincidence spectrometer; the potential use of Auger electrons for coincidence measurements of nuclear quantities; decay energy of ^{139}Ce and lifetime of the 166-keV level in ^{139}La; a coincidence spectrometer method for measuring the K-capture probability applied to ^{111}In; conversion coefficients of the transitions in ^{111}Cd by a new precision method; anomalous internal conversion of the 212-keV transition in ^{121}Te; establishment of an excited state at 1.64 keV in ^{193}Pt; lifetime of 1.6-keV level in ^{193}Pt measured in different chemical environments; and the $\Delta K = 1$ E1 transitions in odd-mass isotopes of Tb and Eu. (Sweden)

42076 COLLECTIVE EXCITATIONS IN ^{206}Pb, ^{207}Pb, ^{208}Pb, AND ^{209}Bi BY INELASTIC ELECTRON SCATTERING. Ziegler, James Francis. New Haven, Yale Univ., 1967. 217p.

Thesis.

Collective excitations in ^{206}Pb, ^{207}Pb, ^{208}Pb, and ^{209}Bi were studied by inelastic electron scattering experiments at the Yale linear electron accelerator. Incident electron energies were from 28 to 83 MeV, and the scattering angles used were from 100 to 150°. This corresponds to a momentum transfer range from $0.26F^{-1}$ to $0.70F^{-1}$. Form factors were found for the 2.61 MeV (3^-) excited states in all four isotopes and the 4.1 MeV (2^+) and 4.3 MeV (4^+) states in the Pb isotopes. The following states in ^{208}Pb were also analyzed: 3.198 MeV, 5.25 MeV, 5.6 MeV, and 6.2 MeV; with the respective tentative assignments of spin and parity: 5^-, 3^- (4^+), 3^-, 2^+ (0^+). The data were analyzed using a distorted-wave Born approximation calculation. The nuclear excited state model of an irrotational incompressible vibrating liquid drop was found to be in excellent agreement with the shape of the 2.61 MeV (3^-) states in all the isotopes, and also with the 4.1 MeV (2^+) and 4.3 MeV (4^+) states in ^{208}Pb. Using this model, reduced nuclear transition probabilities were found for all the levels studied. Transition radii were also extracted, and found to accurately describe the nuclear transition charge distributions for the levels tested in this low momentum transfer range. (Disser. Abstr.)

42077 PROTON SPIN-FLIP PROBABILITY MEASUREMENTS FOR (p,p') ON ^{148}Sm AND ^{152}Sm. Kurepin, A. B.; Christensen, P. R.; Trautner, N. (Univ. of Copenhagen). Nucl. Phys., A115: 471-5(1968).

Proton spin-flip probabilities in the reactions $^{148}Sm(p,p')^{148}Sm(2^+)$ and $^{152}Sm(p,p')^{152}Sm(2^+)$ were measured at 12.0 MeV and, in the case of ^{148}Sm, also at 10.0 MeV and 10.5 MeV, corresponding to excitations of isobaric analogue states. (auth)

42078 ABSOLUTE TRANSITION PROBABILITIES IN ^{193}Ir. Avida, R.; Burde, J.; Molchadzki, A. (Hebrew Univ., Jerusalem). Nucl. Phys., A115: 405-16(1968).

Lifetime measurements of the excited states of ^{193}Ir were carries out by delayed coincidence measurements between the beta spectrum of ^{193}Os and the conversion lines that de-excite the levels, using a double-lens coincidence spectrometer. The mean lifetimes of the 139- and 460-keV levels were determined to be $\tau = 127 \pm 13$ psec and $\tau = 27 \pm 7$ psec, respectively. The upper limits for the mean lifetimes of the 180-, 361-, 712-, and 558-keV levels were found to be $\tau \leq 50$ psec, $\tau \leq 130$ psec, $\tau \leq 160$ psec, and $\tau \leq 300$ psec, respectively. The latter limit was deduced from delayed coincidence measurements between the beta spectrum and the gamma rays. The experimental absolute transition probabilities and static moments deduced from the present work and from previous investigations, could be accounted for by describing the 73-, 139-, 180-, 357-, and 460-keV states by particle-excited core wave functions. (auth)

42079 PROPERTIES OF LEVELS IN ^{132}Ba AND ^{132}Xe POPULATED BY ^{132}Cs. Carter, H. K. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Pinajian, J. J. Nucl. Phys., A115: 417-20(1968).

The energies and intensities of the transitions in the decay of ^{132}Cs were determined with improved accuracy with a 30 cm^3 Ge(Li) detector and 4096-channel analyzer. The following transitions were measured in ^{132}Xe(energies in keV and intensities in parentheses): 363.0 ± 1.0(0.7 ± 0.1), 505.7 ± 0.4(8.3 ± 0.8), 629.8 ± 0.2(10.1 ± 1.0), 667.65 ± 0.09(1000), 772.4 ± 0.4(0.79 ± 0.07), 1135.8 ± 0.2(5.0 ± 0.4), 1297.7 ± 0.5(0.48 ± 0.04), 1317.65 ± 0.15(6.1 ± 0.5) and 1985.3 ± 0.3(0.74 ± 0.07) and 464.5 ± 0.2(18.8 ± 2.0), 567.0 ± 0.8(2.6 ± 0.3) and 1031.4 ± 0.2(1.2 ± 0.1) in ^{132}Ba. The level energies in ^{132}Xe determined from these results are 667.65 ± 0.09, 1297.6 ± 0.2, 1440.1 ± 0.4, 1803.4 ± 0.2, and 1985.30 ± 0.15 keV. The first two excited states in ^{132}Ba are at 464.5 ± 0.2 and 1031.4 ± 0.2 keV. (auth)

42080 GAMMA–GAMMA AND ELECTRON-GAMMA ANGULAR CORRELATION STUDIES IN THE DECAY OF ^{75}Se. Speidel, K.-H.; Kolb, D.; Mittag, K.; Voss, J.; Wolbeck, B.; Dammertz, G.; Plingen, K.-G. (Univ. of Bonn). Nucl. Phys., A115: 421-34 (1968).

The multipolarities of the 121-, 136-, 265-, and 280-keV transitions in the decay of ^{75}Se were determined from $\gamma\gamma$ and $e^-\gamma$ angular correlation measurements. The use of a Ge(Li) detector gave a complete separation of the different γ-lines. Consequently, more reliable results could be obtained than previous NaI(Tl) measurements had given. From the new data of the $\gamma\gamma$ angular correlation experiments for the 265- and 280-keV lines the mixing parameters for the 265- and 280-keV transitions were derived. The $e^-\gamma$ angular correlation measurements were performed using a Si(Li) detector as well as a magnetic-lens spectrometer for the detection of the conversion electrons. From these experiments, for the 121- and 136-keV transitions, the K-shell particle parameters were obtained. These values are in good agreement with the particle parameters for E1 multipolarity calculated by Biedenharn and Rose. (auth)

42081 LEVELS IN THE 89-NEUTRON NUCLEUS ^{153}Gd. Nielsen, H. L.; Wilsky, K. (Univ. of Aarhus, Denmark). Nucl. Phys., A115: 377-84(1968).

The electron-capture of 57-hr ^{153}Tb was studied with isotope-separated sources by means of direct and coincidence spectrometry with a six-gap beta-ray spectrometer and Ge(Li) gamma-ray detetectors. New levels in ^{153}Gd were established at 315.1 and 1103 keV. New relative parity assignments were made for levels at 183.5, 249.6, 315.1, 368.6, 448, 549, 946, and 1103 keV. (auth)

42082 THE DECAY OF ^{150}Eu(12.8 hr). Kugel, H. W.; Buss, D. J.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Nucl. Phys., A115: 385-94(1968).

The γ-ray spectrum of ^{150}Eu (12.8 hr) was studied using a 7 mm × 4 cm^2 Ge(Li) detector to obtain more precise values for the energy levels and transition intensities in ^{150}Sm. The new values for the energies of previously reported transitions are 333.9, 406.5, 620.3, 712.2, 831.8, 917.7, 921.7, 1165.7, 1223.0, 1629.4, and 1963.0 keV; in addition, new transitions of 209.4, 305.4, 425.3, 860.1, 1046.2, 1193.7, and 1452.3 keV were observed. Branching ratios for E1 and E2 transitions de-exciting higher-lying states were obtained. A revised de-

cay scheme is presented and discussed. The half-life of the long-lived ^{150}Eu isomer was measured to be 6.2 ± 0.5 yr. (auth)

42083 ELASTIC DEUTERON SCATTERING ON THE EVEN Nd ISOTOPES. van der Baan, J. G.; Christensen, P. R.; Rasmussen, J.; Tjoem, P. O. (Univ. of Copenhagen). Nucl. Phys., A115: 265-72(1968).

Elastic scattering cross sections for 12-MeV deuterons on the even isotopes of Nd, 142 ≤ A ≤ 150, were measured from 15 to 150°, using a solid-state counter in connection with a magnetic spectrograph. The results were analyzed in terms of the optical model. The optical model parameters were extracted using an optical model automatic search code. A systematic behavior of the optical model parameters, going from the spherical ^{142}Nd to the deformed ^{150}Nd, was found if search on four parameters, U, W, a, and a', was done. (auth)

42084 THE RADIOACTIVE DECAY OF 52-sec ^{196g}Ir AND 1.40-hr ^{196m}Ir. Jansen, J. F. W.; Pauw, H.; Toeset, C. J. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A115: 321-52(1968).

The decay of the ground state of ^{196}Ir ($T_{½}$ = 52 ± 2 s, J^{π} = 0$^-$) and an isomeric state ($T_{½}$ = 1.40 ± 0.02 h, J^{π} = 10$^-$ or 11$^-$) to ^{196}Pt was investigated with Ge(Li), Si(Li), and scintillation detectors. In the ground-state decay, eight gamma-ray transitions were observed between low-spin states at 1135, 1403, 1824, and 1909 keV and the ground state of ^{196}Pt; the spin 0 of the 1135-keV level was determined by an angular correlation experiment. In addition to six earlier reported transitions in the decay of the longer-lived isomer, 28 transitions with relatively much weaker intensity were observed. Multipolarities were measured for the six strongest transitions which form a cascade including four high spin levels with negative parity. Other levels up to 3.3-MeV excitation energy with high spin value are proposed to explain several but not all observed transitions. The observation of the main beta-ray branch (≈80 %, E_{max} = 1.16 ± 0.10 MeV) is hindered by the presence of ^{196}Ir in the source. Two isomers ($T_{½}$ = 2.3 ± 0.2 hr and 3.67 ± 0.08 hr) were found in this isotope decaying with 56 transitions below 1 MeV (observed in the gamma-ray spectrum) to levels in ^{196}Pt. The observed levels in ^{196}Pt are discussed in terms of some nuclear models and compared with other even-mass platinum isotopes and with the isotones in mercury and lead. (auth)

42085 STUDY OF THE EXCITED LEVELS OF ^{117}In. Moret, Roger; Barneoud, Daniel (Institut des Sciences Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 266: 1289-91(May 6, 1968). (In French).

The study of the decay of ^{117}Cd → ^{117}In made it possible to determine 23 excited levels of ^{117}In up to 2457 keV. (tr-auth)

42086 MEASUREMENT OF THE K INTERNAL CONVERSION COEFFICIENT OF THE 86.5-keV TRANSITION OF ^{155}Gd AND OF THE K FLUORESCENCE YIELD OF GADOLINIUM. Oms, Jacques; Foin, Claude; Baudry, Andre (Institut des Sciences Nucleaires, Grenoble, France. Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 266: 1292-4 (May 6, 1968). (In French).

The coefficient α_K (86.5) in the decay ^{155}Eu → ^{155}Gd was measured by a comparative method. The validity at low energy a γ spectroscopic method by external conversion was deduced. The fluorescent yield was determined to be $\bar{\omega}_K$ = +0.909 ± 0.009. Good agreement of this value with theory is noted. (tr-auth)

42087 ISOTOPE EFFECT AND THE DENSITY-DEPENDENT NUCLEON–NUCLEON INTERACTION. Lande, Alexander (Univ. of Copenhagen); Molinari, Alfredo; Brown, G. E. Nucl. Phys., A115: 241-52(1968).

The isotope shift is calculated for ^{208}Pb and for the Ca region in perturbation theory using a density-dependent nucleon-nucleon interaction. Rearrangement terms are estimated, and some connection is made with the Migdal theory of finite nuclei. The density dependence is of great importance in obtaining isotope shifts of the right sign and magnitude. (auth)

42088 THE PAIRING VIBRATIONAL MODEL AND THE ANALYSIS OF THE ^{116,118}Sn(t,p) REACTIONS. Broglia, R. A. (Univ. of Copenhagen); Riedel, C.; Soerensen, B.; Udagawa, T. Nucl. Phys., A115: 273-95(1968).

The reactions ^{116,118}Sn(t,p) are analyzed by using the eigenfunctions of a Rosenfeld-type force diagonalized in a two-quasiparticle basis. Special attention is paid to the J^{π} = 0$^+$ channel which is also studied in the pairing vibrational model. It is concluded that the pairing vibration carries a (t,p) strength of the same order as that carried by two-quasiparticle intrinsic excitations in superconductive nuclei. The presence of high-lying (core excited) 0$^+$ states with large (t,p) intensities is predicted. (auth)

42089 THE (γ,p) REACTION MECHANISM FOR THE NUCLEUS ^{208}Pb. Moskovkin, V. M.; Yadrovskii, E. L. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 5, 109-10(Sept.–Oct. 1967). (In Russian).

The cross section of the reaction ^{208}Pb(γ,p)^{207}Tl was calculated, and the results were compared with experimental data. Good agreement was noted. (R.V.J.)

42090 REDUCED DISTANCES BETWEEN LEVELS OF SOME ISOTOPES, ISOBARS, AND ISOTOPES IN THE REGION OF DEFORMED NUCLEI. Vertebnyi, V. P.; Gnidak, N. L.; Kalchenko, A. I.; Kolotyi, V. V.; Pavlenko, E. A.; Pasechnik, M. V.; Pisanko, Zh. I. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 679-81(Apr. 1968). (In Russian).

The level spacings in ^{163}Dy, ^{162}Er, ^{164}Er, ^{166}Er, and ^{165}Ho were investigated. It was found that the 5.44-eV level, previously assigned to ^{162}Er, belongs to ^{163}Dy. The strength functions, Γ_n^0/D, for ^{163}Er and ^{167}Er were found to be 1.71 × 10^{-4} and 4.9 × 10^{-4}, respectively. (R.V.J.)

42091 LEVEL DENSITY OF COMPOUND NUCLEI EXCITED BY SLOW NEUTRONS. Pisanko, Zh. I.; Golovach, L. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 700-2(Apr. 1968). (In Russian).

Semiempirical formulas for level density that were derived by A. Gilbert et al. (Can. J. Phys., 43: 1446(1965)) are in a good agreement with the experimental data obtained for stable isotopes using the neutron time-of-flight method. An attempt was made to extrapolate the formulas to radioactive nuclei and to the prediction of the level density of neutron-deficient nuclei. The level density was programmed on the M-20 computer. The neutron binding energy was calculated, and the excitation energy was determined by the pair-interaction binding energy calculated in Gilbert's work. Tabulated data for even-even radioactive nuclei showed that with increased atomic number there is a tendency to increased level density. It was also found that in the area of magic nuclei the level density is rapidly reduced and that consideration of deformation reduced the level density 5 to 10 fold. The level density increased with the increasing neutron deficiency; however, for some elements, due to shell effects, the density increase is not a monotonic function. The highest level density was observed during neutron capture by rare earths; the distance between levels was about 0.1 to 1 eV. (R.V.J.)

42092 ELECTRIC DIPOLE TRANSITION FROM THE $2f_{7/2}$ ISOBARIC ANALOG RESONANCE TO THE $2d_{5/2}$ GROUND STATE IN ^{141}Pr. Ejiri, H.; Richard, P.; Ferguson, S.; Heffner, R.; Perry, D. (Univ. of Washington, Seattle). Phys. Rev. Lett., 21: 373-6 (Aug. 5, 1968).

Electric dipole γ rays from the $2f_{7/2}$ isobaric analog state $(2T_0)^{-½}T_-|i\rangle$ to the $2d_{5/2}$ ground state $|f\rangle$ in ^{141}Pr were measured with a Ge(Li) crystal. The matrix element of the E1 γ transition, $|\langle f|m_1T_-(2T_0)^{-½}|i\rangle|$, and that of the analogous first-forbidden β transition, $|\langle f|m_\beta|i\rangle|$, were obtained. (auth)

42093 DECAY OF ^{117}Cd AND ^{117}In. Schwarzbach, E.; Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 8: 225-6(Dec. 1967). (In German).

Preparations of ^{117}Cd were produced by neutron capture and by uranium fission. The half-lives of the ^{117}Cd isomers were analyzed from the β and γ decay measurements using the RADAR computer program. The analysis gave, for the preparation produced by reactor radiation, a mean value of 162.0 ± 3.2 min and for the fission cadmium a value of 173.8 ± 3.5 min. With the formation ratios computed, this gave a half-life of 151 ± 7 min for ^{117g}Cd and 186 ± 6 min for ^{117m}Cd. The γ radiation measured on the mass-separated ^{117}Cd was assigned, and its energy and relative intensity were determined. (J.S.R.)

Nuclear Theory

Refer also to abstracts 40365, 40495, 41943, 41962, 41966, 41995, 42008, 42059, 42061, 42062, and 42087–42089.

42094 (ANL-7439) NUCLEAR STRUCTURE CALCULATIONS. Lawson, R. D. (Argonne National Lab., Ill.). May 1968. Contract W-31-109-eng-38. 18p. Dep. CFSTI.

The structure of the shell-model wave functions for low-lying states of even–even nuclei is examined, and it is shown why one might hope to reproduce energies and some transition rates using the BCS and two-quasiparticle approximations to describe single-closed-shell nuclei. It is demonstrated, by comparison with exact calculations on the nickel isotopes, that if the physical quantity one wants to calculate is not symmetric about $\bar{N}$ (where $\bar{N}$ is the number of nucleons in the physical system one wants to describe)

large errors result when the BCS and two-quasiparticle wave functions are used. To remedy this deficiency, it is necessary to project out of these wave functions the part describing a system with N particles, normalize this part, and then use the normalized projected eigenfunction to calculate the physical quantity of interest. It is also shown that if one does only a two-quasiparticle calculation for the low-lying excited states, one can only reliably predict the B(E2) between the ground state and first 2^+ nuclear level. (auth)

42095 (ANL-Trans-644) RELATIVE PROBABILITIES OF THE EXCITATION OF ISOMERIC STATES DURING RADIATION CAPTURE OF THERMAL NEUTRONS. Malyshev, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Tekhnicheskii Institut). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report FEI-79. 10p. Dep. CFSTI.

The relative probabilities of the formation of isomeric states during the radiative capture of thermal neutrons were calculated on the basis of the statistical theory. The calculations were carried out by a method which considers the distribution of the γ sources in every cascade with the purpose of verification of the dependence of the density of nuclear levels on the total angular momentum. It is shown on the example of 8 odd-odd nuclei for which the isomer ratios differ by ~30 times that if a single theoretical parameter is assigned, namely the density of one-particle states near the Fermi energy, then the agreement with experiment is obtained within the limits of 50%. (auth)

42096 (BNL-50100) THE ATOMIC ELECTRONS AND NUCLEAR TRANSITION: SOME INTERRELATIONSHIPS. Brookhaven Lecture Series Number 72. Perlman, Morris L. (Brookhaven National Lab., Upton, N. Y.). Feb. 28, 1968. 10p. Dep. CFSTI.

Some of the ways in which the electrons of an atom and the nucleus of the same atom influence each other are discussed. Chemical effects of lifetimes or decay probabilities of electron-capture transitions, ionization of the atom associated with some radioactive decay modes, chemical effects on internal conversion, and extraction of information on nuclear structure from measurements of chemical effects are emphasized. (D.C.W.)

42097 (IPNO/TH-117) CURVE FITTING IN OPTICAL MODEL. Hoegaasen, J. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Jan. 1968. 10p. Dep.

The failure of the chi-squared criterion in fitting data with a strongly oscillatory pattern is analyzed, and a more satisfactory criterion is proposed and demonstrated. (D.C.W.)

42098 (JINR-E1-3899) N-N SCATTERING PHASE-SHIFT ANALYSIS AT ENERGIES NEAR 20 MeV WITH A NEW METHOD OF PHASE-SHIFT SETS TESTING. Bilen'kaya, S. I.; Bystritskii, I.; Yanout, Z.; Kazarinov, Yu. M.; Legar, F.; Pazman, A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1968. 30p. Dep.

The results of a phase-shift analysis at the energies of 23.1 and 18.2 MeV are discussed. Two and three solutions remain at the first and second energy, respectively. Measurements of triple n-p scattering parameters are necessary for obtaining the unambiguity of solutions. It is shown that the Berkeley p-p polarization data at 19.7 MeV are in disagreement with other results. For the discrimination of phase-shift solutions, the new so called τ-criterion, based on the calculation of some function τ of the experimental data, is used. This method can be applied, in general, to the arbitrary unambiguous phase-shift analysis. The τ-criterion is more powerful than the χ^2-criterion, e.g., for rejecting the less probable set it is necessary to have a smaller quantity of experimental points (in the statistics it means, that the τ-criterion gives a smaller Type II error). For the calculation of the quantity τ, the standard program for phase-shift analysis with a small additional part can be used. Computer time of about only 5 to 10 min on a computer of M-20 type is needed. Type I error is then obtained from the tables of normal distribution function. (auth)

42099 (JINR-P4-3872) ACCOUNT OF INTERMEDIATE EXCITATIONS IN THE DEUTERON STRIPPING REACTIONS. Dumitresku, O.; Luk'yanov, V. K.; Petkov, I. Zh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 18p. (In Russian). Dep.

An expression was obtained for the deuteron stripping cross section on deformed nuclei. Therefore, the intermediate rotational and nonrotational states were taken into account. The result is illustrated in perturbation theory on residual interactions. Spectroscopic amplitudes of the intermediate transitions are calculated in the microscopic nuclear model. (auth)

42100 (JINR-P4-3935) PROBABILITIES OF THE Eλ TRANSITIONS AND PERMITTED β-DECAY IN THE ODD-MASS NUCLEI. Greev, F. A.; Ivanova, S. P.; Chernei, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. (In Russian). Dep.

The Eλ transitions and the allowed β decay in the odd-mass rare-earth nuclei were considered. The single-particle wave functions of the Woods-Saxon's potential were used in calculations. The values of the above probabilities, which agree well with the experimental results, were obtained, while the Nilsson's model predicts that the account of the effect of the pairing on the probability of the E1 transitions with K = 0 leads to worse agreement with the experimental data. (auth)

42101 (UCD-CNL-95) HILBERT SPACE PROPERTIES OF THE INTERACTION REGION MODEL. Corbett, J. V. (California Univ., Davis. Crocker Nuclear Lab.). Apr. 1, 1968. Contract AT(11-1)-Gen-10. 18p. Dep. CFSTI.

The interaction region model is discussed as a problem in the theory of linear transformations. The Hamiltonian for this model is shown to be a self-adjoint operator under certain, physically reasonable, conditions on the boundary data. The Hilbert space extensions of the domains of this self-adjoint operator and of the self-adjoint Hamiltonian operator for the potential model are proven to be isomorphic. (auth)

42102 (UCID-2823) TABLE OF CLEBSCH-GORDAN COEFFICIENTS AND SPHERICAL HARMONICS. Hess, Dick (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 13, 1966. Contract W-7405-eng-48. 30p. Dep. CFSTI.

An extended table of Clebsch–Gordan coefficients and spherical harmonics is presented. (D.C.W.)

42103 (UUIP-583) THE EFFECT OF NUCLEAR MAGNETIC RESONANCE ON ANGULAR CORRELATIONS AND DISTRIBUTIONS. Olsen, B. A. (Uppsala Univ. (Sweden). Inst. of Physics); Matthias, E. (California Univ., Berkeley. Lawrence Radiation Lab.); Steffen, R. M. (Purdue Univ., Lafayette, Ind. Dept. of Physics). Apr. 1968. 51p. Dep.

The theory is developed for radiative detection of NMR isomeric nuclear states by use of gamma-ray angular correlations and distributions. It is illustrated with numerical examples. The use of multiple radiation fields for detection introduces new and hitherto unobserved line shapes. For rf with random phase, the resonance line is k-fold split, where k is the summation index of the Legendre polynomial expansion. If pulsed rf with a constant phase is used, the form and symmetry of the resonances depend strongly upon the phase and the geometry of the experiment. Using linearly polarized rf with a fixed phase offers, at certain geometries, the possibility of obtaining the relative sign of gH with respect to a reference case. The existence of a "hard core" value at resonance frequency is demonstrated. Various geometries are examined with respect to their applicability in angular correlation or nuclear reaction experiments. Time-differential perturbation factors are discussed and are found to be valuable for a detailed understanding of the resonance effects. (auth) (Sweden)

42104 REACTION MATRIX THEORY OF SINGLE-PARTICLE POTENTIALS IN NUCLEI. Kirson, Michael W. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A115: 49-78(1968).

Starting from the Brueckner-Goldstone expansion for the ground state energy of a system, a number of definitions of the shell-model potential of a nucleus are considered. It is demonstrated that the "best" shell-model potential is obtained by making wide use of generalized time-ordering in an extended factorization procedure, thus generating a potential which is suitable for calculations of linked cluster expansions for all nuclear properties. A variational definition is also considered but is shown to be incorrect. The "true" single-particle energies, as detected in pick-up and stripping reactions, are determined by a method similar to Landau's theory of the Fermi liquid and are shown to be identical to the metastable state energies of Hugenholtz and Van Hove. The difference between these and the shell-model energies defines a re-arrangement energy for each single-particle state. The implications of these results for nuclear computations are briefly discussed. (auth)

42105 NEW EQUATION FOR EQUIVALENT LOCAL POTENTIALS. Fiedeldey, H. (South African Atomic Energy Board, Pelindaba). Nucl. Phys., A115: 97-107(1968).

A new set of coupled equations for the calculation of the equivalent local potential is derived. To obtain these equations the modulus-phase functions are used. Their relation to the Calogero equations is also discussed. (auth)

42106 THEORY OF INTERNAL BREMSSTRAHLUNG FOR FORBIDDEN β DECAY. Gebhardt, Dieter (Univ., Erlangen-Nuernberg, Ger.). Nucl. Phys., A115: 207-12(1968). (In German).

A theory of internal bremsstrahlung is given which is valid for every degree of forbiddenness of the corresponding β decay. The latter is treated in normal approximation. For first-forbidden decay, the cancellation effect is additionally considered. Coulomb effects are taken into account, but terms of order $(\alpha Z)^2$ are neglected in comparison with terms of order 1. (auth)

42107 HAMILTONIAN OPERATOR FOR VELOCITY-DEPENDENT POTENTIALS. Razavy, M. (Univ. of Alberta, Edmonton). Phys. Rev., 171: 1201-2(July 20, 1968).

The Hamiltonian operator for a class of velocity-dependent potentials is studied. It is shown that the Hamiltonian and the energy of the system are not simply related; and while the former is a constant of motion and does not depend on time explicitly, the latter quantity is time-dependent, and the Heisenberg equation of motion is not satisfied. (auth)

42108 OFF-ENERGY-SHELL T-MATRIX ELEMENTS FOR LOCAL POTENTIALS CONTAINING HARD CORES. Laughlin, Robert; Scott, Bruce L. (California State Coll., Long Beach). Phys. Rev., 171: 1196-1201(July 20, 1968).

A method is presented for calculating the off-energy-shell two-body reaction matrix elements for a local potential that contains a hard core. An analytic expression is presented for the matrix elements, t(k′,k; s), for the special case of a hard-core potential with no other interaction. Graphs are presented showing the effects of the hard core for negative values of the energy parameter s and l = 0 relative-angular-momentum states, using a potential of exponential shape and parameters chosen to approximate the nucleon–nucleon interaction. (auth)

42109 SPECTRAL AVERAGES IN TRANSFER REACTIONS INVOLVING TARGETS WITH SINGLE ACTIVE SHELL. Bansal, R. K. (Michigan State Univ., East Lansing. Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 27B: 184-6(July 8, 1968).

The equations relating the energies of the spectroscopic-weighted averages of the spectra obtained in equivalent nucleon transfer reactions involving single-active-shell targets containing only neutrons in their active shell are presented. For the sake of completeness, the results are also given for the case of inequivalent transfer; in this latter case there is no restriction on the neutron–proton composition of the target state. (auth)

42110 (d,p) SPECTROSCOPIC FACTORS FROM THE BUTLER-BORN APPROXIMATION. Peaslee, D. C. (Australian National Univ., Canberra). Phys. Rev., 171: 1208-11(July 20, 1968).

Success in fitting absolute (d,p) cross sections by distorted-wave Born approximation and recent impulse approximations suggest that the original Butler-Born approximation should yield reasonable spectroscopic factors S, provided that a fit can be made to total magnitude while ignoring the details of angular distribution. A procedure of hand calculation is given for this, with expected accuracy of order 30%. Tested on nine (d,p) reactions, it gave satisfactory results in seven or eight cases and no $S \lesssim 0.1$. (auth)

42111 CONCEPT OF IDEAL COLLECTIVE COORDINATE AS THE FOUNDATION FOR A PHENOMENOLOGICAL THEORY OF NUCLEAR COLLECTIVE MOTION: BASIC IDEAS AND RELATION TO OTHER PHENOMENOLOGICAL METHODS. Klein, Abraham; Dreizler, M.; Johnson, Robert E. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev., 171: 1216-23(July 20, 1968). (NYO-2171-240).

The concept of an ideal collective coordinate is introduced by means of the following example. Consider a one-dimensional vibration of a many-body system in the sense that a large subset of states $|n\rangle$ of the system exhibits an energy spectrum and relative transition probabilities following the laws of the (in general anharmonic) oscillator described by $\mathcal{H}(p_\alpha,\alpha)(\alpha/n) = \omega_n(\alpha/n)$. The set of many-body states $|n\rangle$ is assumed to extend indefinitely, and the transform $|\alpha\rangle = \Sigma\,|n\rangle\,(n/\alpha)$ is taken to define a many-body generating state of the band which is precisely localized in α space. The basic assumption of collectivity, that changing the state of at most a few particles can not much alter the value of α, is shown to be sufficient to derive a phenomenological theory from the many-body starting point. The phenomenological aspects of a recent theory of rotations due to Villars is seen to be contained in the above formulation as a special case. A brief review is given of the generator coordinate and similar projection methods in order to exhibit their relationship with the present method. (auth)

42112 APPLICATION OF THE CONCEPT OF IDEAL COLLECTIVE COORDINATE TO A SIMPLE MICROSCOPIC MODEL. Klein, Abraham; Johnson, Robert E. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev., 171: 1224-9(July 20, 1968). (NYO-2171-241).

In a previous paper the concept of an ideal collective coordinate was introduced as the basis for a phenomenological theory of nuclear collective motion. The application of this idea to the microscopic domain is illustrated by the study of a simple two-level model with monopole–monopole interactions, previously considered by Lipkin and collaborators. The complete scheme of calculation which is presented is seen as an alternative to the boson expansion methods currently in fashion for the study of anharmonic vibrations. The new scheme should, however, be applicable to a more extended range of problems such as the adiabatic limit for vibrations and the general problem of rotation-vibration interactions. (auth)

42113 NUCLEAR-MATTER RADII FROM A REFORMULATED OPTICAL MODEL. Greenlees, G. W.; Pyle, G. J.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev., 171: 1115-36(July 20, 1968).

A reformulation of the optical model is developed in which the real parts of the potential are obtained from nuclear-matter distributions and the nucleon–nucleon force. The model is applied to proton elastic scattering data at 14.5, 30.3, and 40.0 MeV and succeeds in fitting the data as well as, or better than, the standard optical model despite the fact that two fewer parameters are needed in the new model. Values, accurate to a few percent, are obtained for the nuclear rms matter radii which are independent of the incident proton energy. These values are greater than the corresponding rms proton radii obtained from electron scattering and muonic x-ray work, and indicate that nuclear neutron rms radii are greater than nuclear proton rms radii by about 0.6 F. Information is also obtained concerning the spin-isospin-independent part of the nucleon-nucleon force, indicating a mean-square radius of 2.25 ± 0.6 F^2 and a volume integral of 400 ± 20 MeV F^3. The neutron and proton density distributions found from this work and muonic studies are used to calculate the imaginary potential, and this is compared with the phenomenological form found in the analyses performed with the new model. The good measure of agreement between the two potentials indicates that the model can be extended to include this term in a more logical manner, and with fewer parameters, than in the standard formulation of the optical model. The model is readily extended, in appropriate cases, for use with complex particles. (auth)

42114 POLARIZATION EFFECTS IN (d,p) REACTIONS ACCORDING TO THE BUTLER–HEWITT–McKELLAR–MAY THEORY. McKellar, Bruce H. J. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 171: 1137-41(July 20, 1968).

Expressions are derived from the Butler-Hewitt-McKellar-May theory of (d,p) reactions for the single polarization effects — the proton polarization, the orientation of the final nucleus [which may be observed through the (d,pγ) reaction], and the cross sections for polarized deuterons and for oriented target nuclei. (auth)

42115 MODEL-INDEPENDENT ANALYSIS OF INELASTIC ELECTRON SCATTERING FROM NUCLEI. I. MONOPOLE AND QUADRUPOLE EXCITATIONS AT LOW MOMENTUM TRANSFER. Schucan, Thomas H. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., 171: 1142-50(July 20, 1968). (YALE-2726-514).

A new method is presented for improving the first-Born-approximation treatment of inelastic electron scattering from nuclei. The main objective of this method is the determination of the Coulomb corrections in a model-independent way. It is shown that this can be achieved by reformulating the results of a modified second-order Born approximation in terms of moments of a radial transition charge density. The results are given for monopole and quadrupole excitations and for low momentum transfer. This method can also be used to calculate the Coulomb corrections for a given nuclear model without a digital computer. The results for various nuclei were compared with the results of partial-wave calculations, and a good agreement was found. The analytic behavior of the corrections as a function of the atomic number, the electron energy, and the momentum transfer was investigated; and it was found that the corrections are generally much larger for monopole than for quadrupole excitations. (auth)

42116 INFLUENCE OF BREAKUP CHANNELS IN ELASTIC SCATTERING OF COMPOSITE PARTICLES. Fishbane, P. M. (Univ. of Wisconsin, Madison); Noble, J. V. Phys. Rev., 171: 1150-63(July 20, 1968).

A treatment of d-α elastic scattering is presented using a simple, physically motivated approximation to include the effects of the ^{4}He(d,np)^{4}He (breakup) channel. This article extends and amplifies preliminary results published earlier. A treatment of the breakup amplitude is given, in addition to a more complete

derivation of the dispersion relation for the elastic amplitude. A closed-form solution is obtained for the elastic particle-wave amplitudes in the one-pole approximation. The elastic phase shifts parametrized in this way are compared with experiment, obtaining good agreement. Thus, the contribution arising from the inclusion of the breakup channel is estimated with some confidence. Since the (tightly bound) ^{4}He nucleus is treated as an elementary particle, the model may be regarded as representing scattering on a polarizable target. From this viewpoint, the implications of the findings for several nuclear structure and reaction theories are discussed. (auth)

42117 RESONANCE WIDTHS AND SPACINGS: THEIR AVERAGES AND DISTRIBUTIONS. Moldauer, P. A. (Argonne National Lab., Ill.). Phys. Rev., 171: 1164-9(July 20, 1968).

Resonance-pole parameters of the collision matrix are calculated from models of the K matrix that are specified by finite statistical samples of poles and residues. The results confirm that in the absence of direct reactions the relation between the average partial width to spacing ratio $\overline{\Gamma}_c/D$ and the transmission coefficient T_c is given by $T_c = 1 - \exp(-2\pi\overline{\Gamma}_c/D)$; that the average absolute values of the diagonal collision-matrix pole residues $\overline{G}_c$ satisfy the inequality $2\pi\overline{G}_c/D \geq T_c/(1 - T_c)^{1/2}$; that the distribution of widths is broader than the usually assumed χ^2 distribution, depending on transmission coefficients and the number of open channels; and that the repulsion of pole spacings disappears as transmission coefficients and the number of open channels increase. The edge effects which distort the results of such finite pole sample calculations are discussed. (auth)

42118 STATISTICAL THEORY OF NUCLEI. Brueckner, K. A.; Buchler, J. R.; Jorna, S.; Lombard, R. J. (Univ. of California, San Diego, La Jolla). Phys. Rev., 171: 1188-95(July 20, 1968).

The energy-density formalism is applied to finite nuclei. The total energy of the many-nucleon system is expressed as a functional $E(\rho)$ of the local density $\rho(r)$, and the ground-state density distribution is found by minimization with respect to $\rho(r)$. The functional of the potential energy is directly derived from a nuclear-matter calculation with variable neutron excess by Brueckner et al. The density-gradient correction which takes care of the density variation at the nuclear surface contains an exchange- and a correlation-energy part. In a first attempt, proton and neutron densities are assumed proportional; therefore the present calculation is limited to light nuclei. The density distributions are found to be of the so-called modified Gaussian type with a cubic polynomial. Binding energy, radius, and surface thickness are in good agreement with experiment. (auth)

42119 ANALYSIS OF ENERGY–ENERGY CORRELATION DATA OF FISSION FRAGMENTS. Seki, Masao (Hiroshima Univ.); Sonoda, Masaaki. Kyushu Daigaku Kogaku Shuho, 40: 482-92(July 1967). (In Japanese).

The PHA data, i.e., the relation in the x-y system, is converted to the amount in the $A_f - E_K$ system with constant fission-fragment mass A_f and constant total kinetic-energy E_K. Then, calculations are made on the total (kinetic) energy distribution of the fission fragments, the mass distribution, and the average total (kinetic) energy distribution. These methods of calculation and the ALGOL-H program code FACE used for the calculations are described. In calculating $YLD(m,E_K)$ and $\epsilon YLD(m,E_K)$ from the PHA data A(i,j), with 0.02 and 5 MeV as the intervals m_H and E_{KH} (corresponding to the channel widths in the x and y axes), about 2000 places of memory for the values of $YLD(m,E_K)$ and $\epsilon YLD(m,E_K)$ are required. The shortage is then about 1000 with the OKITAC-5090 H; and the m_H and E_{KH} were taken as 0.04 and 10 MeV. With the FACE, ~12 min were taken to perform all the calculations before and after the symmetrization process. $YLD(m,E_K)$, $\epsilon YLD(m,E_K)$, f(m) and h(m), for ^{232}Th with 32.6-MeV α particles with the FACE code are given. (NSA of Japan)

42120 STABILITY OF MATTER. II. Lenard, A. (Indiana Univ., Bloomington); Dyson, Freeman J. J. Math. Phys. (N. Y.), 9: 698-711(May 1968).

The stability of a system of charged point particles is proved under the assumption that all negatively charged particles are fermions. A lower bound on the energy is found to be $-Aq^{5/3}Nme^4\hbar^{-2}$, where q is the number of distinct negative species, N the total number of negative particles, m an upper bound for their mass, e an upper bound for the absolute value of the charge on both negative and positive particles, and A is a numerical constant. (auth)

42121 SYMMETRY OF THE THEORETICAL OPTICAL POTENTIAL AND ITS CONNECTION WITH TIME REVERSAL AND RECIPROCITY. Dillon, G.; Passatore, G. (Univ., Genoa. INFN, Genoa). Nucl. Phys., A114: 623-8(1968).

An explicit derivation of a general property of symmetry of the nonlocal optical potential is given by using the projection operators. Such a property, which in a particular case reduces to the symmetry in the position coordinates, ensures the relation of reciprocity and follows from the reversibility of the original multi-channel system. (auth)

42122 THEORY OF SELF-CONSISTENT CORE-PARTICLE COUPLING MODELS AND ITS RELATION TO PHENOMENOLOGICAL MODELS. Do Dang, G.; Dreiss, G. J.; Dreizler, R. M.; Klein, A.; Wu, Chi-Shiang (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., A114: 481-500(1968).

Starting from a conventional shell-model Hamiltonian and studying the equations of motion of single fermion operators, an effort is made to derive systematically various intermediate coupling core–particle interaction models in use for vibrational nuclei. An essential postulate that enters the usual treatments, the kinematical independence of core and particle modes, is rephrased as the assumption that the available single-particle modes must be unoccupied in the core. This limitation has been heeded in some of the applications, which are reviewed. The formal extension of the theory to the case where the core and particles are not kinematically independent is carried out, and seen to yield an eigenvalue problem resembling mathematically that of the problem of small vibrations of a mechanical system. The entire class of models, in which core properties are assumed known beforehand, is then considered as an approximation to a self-consistent theory of (simultaneous) core–particle and core–hole coupling which seeks to determine core properties (even nucleus) and core–particle properties (odd nucleus) hand-in-hand. As an application of the latter not previously discussed, the core–particle model for deformed nuclei is derived in the case of strong Coriolis mixing. The existence of corrections to this model which can be studied by the methods is indicated. (auth)

42123 VARIATIONAL PRINCIPLES FOR A SELF-CONSISTENT THEORY OF COLLECTIVE MOTION. Do Dang, G.; Dreiss, G. J.; Dreizler, R. M.; Klein, A.; Wu, Chi-Shiang (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., A114: 501-11 (1968).

A variational formulation is developed for the theory of collective motion derived by other methods in previous papers. The essential observation is that the stationary property is associated with the trace of the Hamiltonian over the sub-space of core states included in any given example. The cases worked out are: a hole–core coupling model; a model where hole–core and particle–core amplitudes are coupled to each other, but only multipole (field-producing) components of the nuclear interactions are taken into account, and a model which, in addition to the above, includes pairing correlations. (auth)

42124 DISCOVERY AND MECHANISM OF FISSION. Frisch, O. R. (Cambridge Univ., Eng.); Wheeler, J. A. Phys. Bull. London, 19: 13-20(Jan. 1968).

An account of the discovery and mechanism of fission is given. (UK)

42125 GENERAL FORMULAS FOR DESCRIBING THE ABSORPTION OF POLARIZED PHOTONS BY ORIENTED NUCLEI. Arenhoevel, Hartmuth (National Bureau of Standards, Washington, D. C.). Phys. Rev., 171: 1212-16(July 20, 1968).

The cross section for the absorption of polarized photons by oriented nuclei is given in terms of the nuclear orientation parameters and the photon polarization parameters for linear and circular polarization. All quantities are given in terms of the nuclear polarizabilities, which contain the electric and magnetic transition matrix elements. The polarizabilities of higher than zero rank contribute to the absorption cross section only if the nucleus is oriented. Without photon polarization, only the even-rank polarizabilities affect the absorption cross section. Photon polarization effects show up only with oriented nuclei. In that case the polarizabilities of odd rank are connected with circular photon polarization, while those of even rank are connected with linear photon polarization. The latter is not true if time-reversal invariance is violated. Finally, the contributions of the various multipole transitions to the polarizability of given rank can not be separated experimentally. (auth)

42126 T = 1 EFFECTIVE INTERACTION IN THE sd SHELL. Cohen, S. (Argonne National Lab., Ill.); Lawson, R. D.; Pandya, S. P. Nucl. Phys., A114: 541-50(1968).

The effective interaction in T = 1 two-body states in the sd shell is parameterized in terms of radial matrix elements of the effective potential in states of relative orbital angular momenta of two nucleons. Seven of these parameters are needed to define all the T = 1 matrix elements with the assumption of a central potential. The values of these parameters are determined by making a least-

squares fit to 16 observed level energies in the oxygen isotopes and are then compared with values calculated from various realistic free nucleon–nucleon interactions. It is shown that a major effect of core excitation and consequent renormalization of the two-body matrix elements, so forcefully pointed out by Kuo and Brown, consists of a strong modification of the contributions of the triplet-odd force. Two-body matrix elements calculated with the parameters are also found to agree well with those determined by Glaudemans et al., from a least-squares fit to observed level schemes of nuclei with A = 29 to 40. (auth)

42127 FISSION SADDLE POINT CALCULATIONS WITH THE INCLUSION OF SHELL EFFECTS. Nardi, E. (Israel Atomic Energy Commission, Rehovot. Weizmann Inst. of Science, Rehovot, Israel); Boneh, Y.; Cheifetz, E. Phys. Lett., 27B: 144-6 (June 24, 1968).

Fission saddle point calculations which include a quantitative description of shell effects have been performed on the basis of the liquid drop model. The results show that relatively small shell corrections are decisive in causing asymmetric saddle point shapes. (auth)

42128 STUDY OF THE (p,2p) REACTION IN THE ENERGY REGION 160 MeV TO 1 GeV. Jackson, Daphne F.; Jain, B. K. (Univ. of Surrey, London). Phys. Lett., 27B: 147-9 (June 24, 1968).

The theoretical approach which yields reasonable agreement with the data on the symmetric coplanar (p,2p) reaction at 160 and 460 MeV was used to make predictions for incident energies up to 1 GeV. (auth)

42129 STATISTICAL THEORY OF POLARIZED NUCLEAR REACTIONS. Kujawski, E.; Krieger, T. J. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 27B: 132-5 (June 24, 1968).

The influence of incident beam polarization on nuclear cross section distributions in the continuum region is investigated on the basis of specific assumptions concerning the statistical properties of the S-matrix. The average polarization of scattered beams induced by unpolarized incident beams is also considered. (auth)

42130 CHARGE-EXCHANGE IN THE (d,p) STRIPPING REACTION. Zimanyi, J. (Central Research Inst. for Physics, Budapest); Gyarmati, B. Phys. Lett., 27B: 120-1 (June 24, 1968).

A theoretical treatment of (d,p) reaction handling symmetrically the two nucleons and including charge exchange potential in a way consistent with DWBA is presented. Due to a few plausible assumptions, the obtained equations reduce to ones easy to work with in numerical calculation. Every one-particle function is entirely determined. (auth)

42131 TWO-PARTICLE TRANSFER REACTIONS. Sakamoto, Y. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim., 56B: 359-62(Aug. 11, 1968).

The transition-matrix element for the two-nucleon pick-up process is studied assuming that the incident proton hits a nucleon pair and forms a triton or ^{3}He particle with the nucleon pair which leaves the target nucleus. The cross section for the reaction $^{12}C(p,^3He)^{10}B$ is calculated as an example. (D.C.W.)

42132 INTERFERENCE BETWEEN COLLECTIVE AND DIRECT NUCLEON RADIATIVE CAPTURE. Longo, G.; Saporetti, F. (Comitato Nazionale Energia Nucleare, Bologna). Nuovo Cim., 56B: 264-78(Aug. 11, 1968).

The interference term between direct and collective dipole radiation capture of nucleons by nuclei is obtained. The cross section is written in a Breit-Wigner form as a sum of three terms: direct capture, collective or resonant capture, and an interference term. The expression of the latter term is investigated, and the conditions for constructive, destructive and zero interference are given. The nucleon capture cross sections for ^{130}Te, ^{142}Ce and ^{208}Pb are calculated. Taking into account the interference between direct and collective processes, a better agreement between theory and experiment is achieved. (auth)

42133 STRUCTURE AND SCATTERING IN NUCLEAR PHYSICS. Adams, Jerry Lee. Tallahassee, Florida State Univ., 1967. 179p.

Thesis.

The energy levels of the first eight low-lying negative-parity states in ^{90}Y were calculated using a delta function interaction between the proton and neutron. The calculated energies for the 2^-, 3^-, 0^-, 1^-, 2^-, 1^-, 4^-, and 3^- states were 0.00, 0.20, 1.26, 1.42, 2.50, 2.81, 3.00, and 3.14, respectively. These agreed well with the experimental values of 0.00, 0.20, 1.21, 1.37, 2.50, 2.63, 3.00, and 3.16. Comparisons to other calculations were made. Next, the lifetime of the weakly bound $\frac{1}{2}^+$ state in ^{17}F was calculated using Woods–Saxon and harmonic oscillator wave functions. The values were 5.1×10^{-19} and 15.4×10^{-19} sec., respectively. The former agreed much better with the experimental value of $(3.5 \pm 1.5) \times 10^{-19}$ sec. The structure information which could be obtained by investigating proton elastic scattering to form isobaric analogue states as resonances in the compound nucleus was studied. The general theory of such reactions was described, and the resonance near 6.0 MeV in the $^{92}Zr(p,p)^{92}Zr$ and $^{92}Zr(p,n)^{92}Nb$ reactions was analyzed. This was the analogue of the 0.96 MeV $\frac{1}{2}^+$ level in ^{93}Zr. The best value for the resonance mixing phase, a previously neglected quantity, was found to be about +10° for this resonance. Next, it was shown that the j value of an analogue resonance, and hence the bound parent state, could be easily determined by doing a polarization experiment using spin zero target nuclei. A method for calculating neutron spectroscopic factors from a modified R-matrix theory was given, and the spectroscopic factor for the 0.96 MeV $\frac{1}{2}^+$ state in ^{93}Zr was found to be 0.58. The resonance mixing phase was also calculated and found to be 12°. Both of these quantities varied only slightly with radius around a one fermi range near 6.6 F. Thus, the problem of which radius to choose was easily resolved. The effects of changing the various optical and bound state parameters, especially the diffusenesses, were found to be quite important. The spectroscopic factors for the $3s_{\frac{1}{2}}$ and $2d_{\frac{5}{2}}$ states in the odd tin isotopes were also computed, but the optical parameters were not well known. Hence, they should be regarded as tentative values. Polarization studies on spin $\frac{1}{2}$ target nuclei near analogue resonances were considered. When channels with two different l values are possible, it was shown that the partial widths and the corresponding spectroscopic factors could be obtained through polarization experiments. Sample calculations were made on the 1^- resonance near 6.1 MeV in $^{89}Y(p,p)^{89}Y$, but no experiments have as yet been done. The inhomogeneous R-matrix theory was then considered. This is simply standard R-matrix theory with boundary conditions which depend on the level involved. The collision function for the one channel case was derived in three different ways, and some sample calculations on s-wave neutrons scattered from a square well potential were done. The R-matrix for the many-channel case was derived using the L-operator technique. The problem of constraining harmonic oscillator wave functions to having the correct asymptotic boundary conditions was next considered using the L operator. Some sample calculations on the neutron wave functions in ^{90}Y were done to demonstrate the procedure. Other applications of the inhomogeneous R-matrix theory were discussed. (Diss. Abstr.)

42134 MULTI-NUCLEON TRANSFER REACTIONS ON DEFORMED NUCLEI. Ascuitto, Robert J. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 145p.

Thesis.

Differential cross sections were determined, in the plane-wave Born approximation, for both two- and three-nucleon stripping reactions. Particular emphasis is placed on describing the target and final product of the reaction by a model which can explain, in a consistent way, the basic physical properties of these nuclei. The model considered was the strong coupling rotational model with axial symmetry. The range of validity of this model is $17 \leq A \leq 40$. The importance of these reactions as a tool for the study of nuclear structure is indicated. Various reactions are considered to demonstrate the usefulness of the two-nucleon stripping reaction for the study of specific types of nuclei. The stripping interaction is considered in both the independent-particle model and the cluster approximation limit; in the latter case, nuclear shape effects are taken into account. (Diss. Abstr.)

42135 STABILITY CONDITION OF THE HARTREE–FOCK STATES AGAINST FOUR-BODY CORRELATIONS. Suzuki, Kenji (Kyushu Inst. of Tech., Kitakyushu, Japan). Progr. Theor. Phys. (Kyoto), 39: 1180-92(May 1968).

The stability condition of the Hartree-Fock states against the four-body correlations is discussed and formulated in the framework of the new Tamm–Dancoff approximation extended to the four-particle scattering eigenmode. Important contributions of the pair-scattering interactions to the stability problem are asserted. Finally, the conclusion of the instability of the Hartree–Fock states is deduced. (auth)

42136 ELEKTROMAGNITNYE PEREKHODY V YADRAKH. (Electromagnetic Transitions in Nuclei). Starodubtsev, S. V.; Begzhanov, R. B. (eds.) Tashkent, Izdatel'stvo FAN Uzbekskoi, SSR, 1966. 219p.

Papers (26) dealing with systematic data on transitions of the type $2_1^+ \rightarrow 4_1^+$ are included. Experimental data on E2 transitions from the second 2^+ level to the lower 4_1^+, 2_1^+, and 0^+ levels of even-even nuclei in the range $152 \leq A \leq 192$ and $A \geq 228$ are

given. Comparisons are made with theoretical predictions. (R.V.J.)

42137 INCOHERENCE OF RESONANT AND NONRESONANT AMPLITUDES IN REACTIONS A(x,y)B*(z)C. Levin, F. S. (Brown Univ., Providence). Nucl. Phys., A115: 449-56(1968).

Previous results on particle-transfer reactions populating particle unstable states have been extended to include nonresonant contributions. It is shown that on resonance, the resonant and nonresonant amplitudes contribute incoherently to the one-particle angular distribution $d^2\sigma/d\Omega_y dE_y$, where y is the first emitted particle in the reaction A(x,y)B*(z)C. The results are discussed in the framework of the doorway-state model of intermediate resonances, and some relevant particle-transfer experiments are suggested. (auth)

42138 NOTE ON NONLOCAL POTENTIALS. Bertero, M. (Univ., Genoa); Talenti, G.; Viano, G. A. Nucl. Phys., A115: 395-404(1968).

The asymptotic behavior of the phase shifts for large (physical) values of the angular momentum and the threshold behavior at zero energy are determined for a class of non-local potentials. (auth)

42139 TRIPLE SCATTERING OF ELECTRONS. van Duinen, R. J.; Aalders, J. W. G. (Rijksuniversiteit, Groningen, Netherlands). Nucl. Phys., A115: 353-63(1968).

The scattering of electrons in the field of a nucleus involves two complex functions f and g. An experimental determination of f and g up to an arbitrary phase-factor requires three independent experiments. Measurements of the differential cross section and double-scattering experiments have been reported in the literature. A new experiment, measuring the change of the polarization vector in large-angle scattering, is described. The results obtained so far differ from theoretical predictions, even if screening effects are taken into account. (auth)

42140 PROTON TRANSFER IN HEAVY-ION REACTIONS. Buttle, P. J. A.; Goldfarb, L. J. B. (The Univ., Manchester, Eng.). Nucl. Phys., A115: 461-70(1968).

The DWBA formalism is applied to heavy-ion proton transfer at energies below the Coulomb barrier where the distortion is mainly Coulombic. Application is given to the $^{10}B(^{14}N,^{13}C)^{11}C$ reaction. (auth)

42141 PCAC AND THREE-BODY FORCES IN NUCLEI. Brown, G. E.; Green, A. M.; Gerace, W. J. (Princeton Univ., N. J.). Nucl. Phys., A115: 435-48(1968).

Using the consistency condition on strong interactions implied by a partially conserved axial-vector current together with reasonable assumptions about the behavior of the pion-nucleon scattering amplitude under extrapolation in the pion mass, it is shown that long-range three-body forces in nuclear matter are essentially zero. This implies that they are also small in nuclei. (auth)

42142 EFFECTS OF TRANSLATIONAL INVARIANCE VIOLATION IN PARTICLE-HOLE CALCULATIONS. APPLICATION TO ^{208}Pb. Palumbo, F.; Prosperi, D. (CNEN, Rome). Nucl. Phys., A115: 296-308(1968).

Recently a method was developed to avoid the troubles arising from the lack of separation of the center-of-mass motion from the intrinsic motion in shell-model calculations. This method has been applied here to the calculation of the 1^- levels of ^{208}Pb in the Tamm–Dancoff approximation with a schematic potential. It has been found that in the usual calculations, the spuriosity can have very large effects on the transition probabilities (a factor of 100 in the worst case) but very small effects on the eigenvalues (about 10^{-2} MeV). The method indeed provides eigenfunctions which are practically free from spuriosity. (auth)

42143 PROPERTIES OF THE KNOCKOUT-EXCHANGE AMPLITUDES IN NUCLEON–NUCLEUS SCATTERING. Atkinson, Jay (Univ. of California, Livermore); Madsen, V. A. Phys. Rev. Lett., 21: 295-7(July 29, 1968).

It is found that the knockout-exchange contribution to inelastic-scattering processes is very large in many cases, the exchange being relatively more important for high orbital-angular-momentum transfer. The phases of direct and exchange amplitudes as a function of scattering angle are remarkably close to being the same. Inclusion of exchange in the excitation of the collective 2^+ state in ^{116}Sn increases the cross section by a factor of 2 compared with the direct amplitude alone. (auth)

42144 SUM RULE FOR THE NUCLEON MASS. Gross, David J. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 21: 308-11(July 29, 1968).

A sum rule for the nucleon mass is derived in a theory which expresses the energy-momentum tensor in terms of currents. A rough evaluation indicates that it is not inconsistent with experiment. (auth)

42145 SPECTROSCOPIC FACTORS FROM (d,p) REACTIONS. Garcia, J. D.; Pearson, C. A. (Univ. of Arizona, Tucson). Phys. Rev. Lett., 21: 301-3(July 29, 1968).

The spectroscopic factor dependence of the revised model of Butler et al. for deuteron stripping is examined. It is shown that the factor $(1-S)^{-2}$ multiplying the cross section in this model results from an incorrect evaluation of a matrix element. The correct evaluation reduces the revised-model matrix element to the original Tanifuji–Butler result. (auth)

42146 SHADOW EFFECT APPEARING AT THE INTERACTION OF FAST CHARGED PARTICLES WITH SINGLE CRYSTALS. Tulinov, A. F. Vestn. Mosk. Univ., Ser. II. Fiz. Astron., No. 5, 88-98(Sept.-Oct. 1967). (In Russian).

A brief review is given on the shadow effect and on the use of the effect for determining the time span of nuclear reactions. The relation between the shadow effect and the channelling effect was analyzed and evaluated. (R.V.J.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 39976, 40152, 40177, 40226, 40298, 40299, 40335, 40336, 40352–40354, 41131, and 42350.

42147 (AEC-tr-6948) PHENIX. Rozenholc, M. Translated for Atomic Power Development Associates, Inc., Detroit, Mich., from Energ. Nucl. (Paris), 10: No. 2, 65-75(Mar.-Apr. 1968). 28p. Dep. CFSTI.

The prototype fast sodium-cooled power reactor PHENIX is described and the development objectives of the planned reactor are discussed. Preliminary design and performance data for the principal reactor components are discussed, and general characteristics of the power plant conventional components are examined. (H.D.R.)

42148 (AECL-3067) THE TWELFTH AECL SYMPOSIUM ON ATOMIC POWER HELD AT OTTAWA, ONTARIO, APRIL 18–19, 1968. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1968. 64p. (CONF-680443). Dep. CFSTI. CAN $2.00.

Separate abstracts are included for all of the seven papers presented. (D.C.C.)

For abstracts of individual papers see: 42149–42154 and 42354.

42149 (AECL-3067, pp 1-19) THE CANDU-PHW NUCLEAR POWER SYSTEM. Foster, J. S.

A review of the development of nuclear power plants in Canada is presented. Capital costs for Canadian, U. K., and U.S.A. nuclear power plants are discussed. A brief review of NPD Reactor operations is presented. Power production and heavy water losses for CANDU Reactor operations are described. Canadian investments in the development of foreign nuclear power plants are also described. (D.C.C.)

42150 (AECL-3067, pp 29-33) RADIATION PROTECTION AND NUCLEAR POWER. Marko, A. M. (Chalk River Nuclear Labs., Ont.).

A quantitative estimate of the risk of an occupation in the nuclear power industry is evaluated and then related to other occupational risks in our society. (D.C.C.)

42151 (AECL-3067, pp 35-43) THE ROLE OF AECL LABORATORIES. Haywood, L. R. (Chalk River Nuclear Labs., Ont.).

A review of research and development achievements of AECL operated laboratories at Chalk River, Ottawa, Toronto, and Whiteshell is presented. A description of AECL participation in Canadian nuclear industry development is also presented. (D.C.C.)

42152 (AECL-3067, pp 45-52) CANADIAN NUCLEAR FUEL: CHALLENGES MET AND PENDING. Mooradian, A. J. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba).

An outline of the present position of the Canadian fuel program, the accomplishments, and expected developments are presented. The development and fabrication of the CANDU Reactor fuel bundle are described. (D.C.C.)

42153 (AECL-3067, pp 53-9) CANDU-BLW. Pon, G. A.

A description of the construction schedule for the Gentilly Power Reactor is presented. (D.C.C.)

42154 (AECL-3067, pp 61-4) LOOK TO THE FUTURE. Lewis, W. Bennett.

An economic analysis of optimum fuels and fuel cycles for Canadian nuclear power plants is presented. (D.C.C.)

42155 (AECL-3068) THE PERFORMANCE OF ZIRCONIUM ALLOY CLAD UO_2 FUEL FOR CANADIAN PRESSURIZED AND BOILING WATER POWER REACTORS. Page, R. D.; Lane, A. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1968. 38p. (CONF-680601-28). Dep. CFSTI. CAN $1.00.

Canada's power reactor fuel industry has until recently been based on the production of fuel for the CANDU-PHW reactor concept. The most recent information on the performance of this type of fuel is given; the results of an extensive irradiation program to develop fuels for boiling water cooled reactors is summarized. In particular, data are presented on the behavior of the reference fuel for the CANDU-BLW-250 reactor and the many single element irradiations undertaken in the X-4 and X-6 loops in NRX. (auth)

42156 (AECL-3081) SUPER-CONVERTER OR VALU-BREEDER: A NEAR-BREEDER URANIUM-THORIUM NUCLEAR FUEL CYCLE. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1968. 26p. (DM-94). Dep. CFSTI. CAN $1.00.

A special way of operating a thermal neutron near-breeder reactor with both thorium and natural uranium fuel supported by some extra neutrons produced as cheaply as possible is described and illustrated. Initially the cheapest source of the extra neutrons will be from a low enrichment of the uranium. The near and long term economic advantages of such a cycle promise to justify the special name of superconverter or valubreeder. The high credit value of long irradiated thorium fuel is the key to the value gain. The high burn-up of each type of fuel keeps the cost contributions from fuel fabrication and reprocessing low. The claim made for the valubreeder is not that its yield as a near breeder is the highest attainable but that as nuclear power develops to large units and complexes the cycle is likely soon to become, and then to remain, one of the lowest cost overall fuel cycles. (auth)

42157 (AECL-3136) CANADIAN INCENTIVE FOR FUEL REPROCESSING AND PLUTONIUM RECYCLE. Stewart, D. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1968. 25p. (CONF-680601-29). Dep. CFSTI. CAN $1.00.

A review is made of likely opportunities in CANDU fuel cycles over the next 20–25 years. The following matters are considered: the anticipated Canadian growth in nuclear power and associated fuel requirements; the broad supply and demand situation for uranium and plutonium; the installation of fuel reprocessing facilities in Canada; and the role of plutonium in CANDU fuelling cycles. (auth)

42158 (ANL-7460) REACTOR DEVELOPMENT PROGRAM. Progress Report, June 1968. (Argonne National Lab., Ill.). July 29, 1968. Contract W-31-109-eng-38. 136p. Dep. CFSTI.

Highlights of project activities are summarized for the month of June 1968. For detailed summaries, see the annual reports from the following ANL divisions: Chemical Engineering, Metallurgy, Reactor Engineering, and Reactor Physics. During June the EBR-II was operated for 659 MWdt in a run with a full complement of fueled experimental subassemblies and a reference run with reflector subassemblies of stainless steel rather than depleted uranium. Nearly normal production was resumed in the Fuel Cycle Facility hot line. Experiments continued with the ZPR-3 Assembly 52, the second core of the FTR Phase-B critical program. Installation of the ZPPR reactor assembly and associated equipment was completed, and seal door and containment structure testing is in progress. Nuclear safety studies, including TREAT operations, and chemical separations activities are discussed. (H.D.R.)

42159 (BAW-3867-3) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. Quarterly Technical Report, January–March 1968. Roy, D. H. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Contract AT(30-1)-3867. 22p. Dep. CFSTI.

Progress in the development of the design-oriented, one-dimensional criticality and depletion code FARED for the physics analysis of fast reactors is summarized. The REGA library tape preparation and maintenance code RETAP and modifications to the REGA routine code STRIP are described. (H.D.R.)

42160 (BMI-1844) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, April–June 1968. Morrison, David L.; Carbiener, Wayne A.; Ritzman, Robert L.; (and others) (Battelle Memorial Inst., Columbus, Ohio). July 1, 1968. Contract W-7405-eng-92. 60p. Dep. CFSTI.

REACTORS, PRESSURIZED-WATER—fuel rods for conceptual 1000 MWe, determination of cladding hot spot temperature transients for; coolant loss accidents in, analysis of radiolytic production of hydrogen during; containment system for, estimated radiolytic hydrogen produced by spray and coolant decomposition in

REACTOR FUEL ELEMENTS—temperature transients for uranium dioxide pressurized water, use of NURLOC-code for determination of; cladding for, stresses caused by zirconium dioxide phase change in; stress distribution in rod-type, mathematical model for determining compressive; cladding for, time dependence of oxygen saturation of zircaloy; fission product release from molten, estimated half-life of

REACTORS, WATER-COOLED—blowdown calculations for, development of pressure-coupled core-cooling model for;

coolant loss accidents in, analysis of radiolytic production of hydrogen during; coolant for 1000 MWe, effects of fission product iodine energy on decomposition of
REACTOR SAFETY—blowdown calculations for, development of pressure-coupled core-cooling model for; coolant loss accidents, analysis of radiolytic production of hydrogen during; coolant loss accidents for, estimated radiolytic hydrogen produced by spray and coolant decomposition during; fission product removal from reactor containment system for, efficiency of reactive sprays for; pressure-suppression pools for, analysis of steam condensation and fission product entrainment in
ZIRCALOY—oxygen saturation of, time dependence of; oxygen saturation of, intercomparison of mathematical models for
REACTORS, BOILING—coolant loss accidents in, analysis of radiolytic production of hydrogen during; containment system for, estimated radiolytic hydrogen produced by spray and coolant decomposition in
REACTOR CONTAINMENT SYSTEMS—methyl iodide removal from, efficiency of sprays for; sprays for, rates for methyl iodide uptake by reactive; pressure- suppression pools for, analysis of steam condensation and fission product entrainment in
HYDROGEN—production during coolant loss accidents in water cooled reactors, analysis of radiolytic
FISSION PRODUCTS—release from molten fuel, estimate of half-life of (M.L.S.)

42161 (BMI-X-10237) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, April–June 1968. Genco, Joseph M.; Rosenberg, Harvey S.; Berry, David A.; Berry, Warren E.; Cremeans, George E.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). July 1, 1968. Contract W-7405-eng-92. 30p. (EURAEC-2054). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

IODINE—deposition on prefilmed Type 304 stainless steel and Zircaloy 4 surfaces, (E); deposition on reactor containment system coatings, (E); removal from air-steam mixtures, effectiveness of reactor containment system scavenger coatings for, (E/T)
TELLURIUM—deposition on prefilmed Zircaloy 2, (E)
METHANE, IODO—removal from air-steam mixtures, effectiveness of reactor containment system scavenger coatings for, (E/T)
REACTOR CONTAINMENT SYSTEMS—coatings for, removal of iodine and methyl iodide by scavenger, (E/T)
WATER—effect on methyl iodide deposition on reactor containment system coatings, (E)
REACTORS, WATER COOLED—coolant loss accidents in, fission-product iodine transport and deposition following, (E/T)
REACTOR SAFETY—fission product deposition under water-cooled reactor accident conditions, (E/T)
FISSION PRODUCTS—deposition of iodine under water-cooled reactor accident conditions, (E/T)

42162 (BNWL-254) PROGRESS REPORT ON FUEL RE-USE. II. ANALYSIS OF FOUR FAST-THERMAL REACTOR COMPLEXES. Hennig, R. J.; Nail, J. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 93p. Dep. CFSTI.

Fuel cycle cost analyses are given for fast, heavy water moderated, boiling water, pressurized water, and variable spectrum heavy water reactors. Plutonium isotope buildup is shown as a function of fuel exposure; burnup and power ratios are given. Economic parameters for a standard ^{233}U cycle and a fuel re-use cycle are tabulated. (M.L.S.)

42163 (BNWL-726) CORROSION AND WEAR SURVEILLANCE IN THE PLUTONIUM RECYCLE TEST REACTOR THROUGH DECEMBER 1967. Richman, R. B.; Pollock, C. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 25p. Dep. CFSTI.

Continuing surveillance of corrosion and wear at the PRTR involves visual, X-ray, and ultrasonic inspections of selected parts of every fluid system, and measurements from electrical resistance probes and coupon samples in some of the systems. All PRTR systems are in good condition, except for certain portions of the secondary system, where repairs of conventional equipment have been required, mainly due to mechanical damage. (auth)

42164 (BNWL-775) REACTOR PHYSICS DEPARTMENT TECHNICAL ACTIVITIES QUARTERLY REPORT, JANUARY–MARCH 1968. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 104p. Dep. CFSTI.

COMPUTER PROGRAMS—EDPM, for mapping closed unit circle onto closed hexagon, FORTRAN 4 and 5 for UNIVAC 1107 and 1108
PHYSICAL CONSTANTS TESTING REACTOR—physics measurements for thorium oxide (ThO_2)–uranium oxide (UO_2)-fueled, description of; core configurations for T-shaped Supercell and 6 × 6 Test Cell in, description of; kinetics of Phoenix Core in, measurement of
REACTIVITY—measurements of PCTR thorium oxide (ThO_2)–uranium oxide (UO_2) lattice, description of; measurements of PCTR Phoenix Core, description of; measurements of trisected FTR core, description of; measurement of plutonium oxide (PuO_2)–uranium oxide (UO_2)-fueled zoned and unzoned core, optimum fuel cycle management from
URANIUM OXIDES UO_2—PuO_2–UO_2, fast fission factor for water-cooled graphite-moderated lattice of, calculation of; PuO_2–UO_2, kinetics for trisected FTR core of, calculation of optimum; PuO_2–UO_2, fuel cycle management of, comparison of zoned and unzoned core
REACTOR FUEL ELEMENTS—fabrication of Phoenix MTR plate-type, description of
FAST TEST REACTOR—core configuration for, calculation of optimum reference design of trisected; kinetics for plutonium oxide (PuO_2)–uranium oxide (UO_2)-fueled, comparison with NPTF of
NEUTRONS, FAST—flux distribution in trisected FTR core, measurement of
CRITICAL ASSEMBLIES—kinetics for plutonium oxide (PuO_2)–uranium oxide (UO_2)-fueled NPTF, comparison with FTR of
KRYPTON ISOTOPES, XENON ISOTOPES—gas release to FTR cover gas of, analysis of
FAST FLUX TEST FACILITY—coolant gas activation in, analysis of argon and nitrogen
ARGON SYSTEMS, NITROGEN SYSTEMS—activation of FFTF coolant gas, analysis of
SODIUM—shielding properties of liquid, analysis of FTR neutron flux
PLUTONIUM NITRATES $Pu(NO_3)_4$—criticality of slab-shaped, analysis of
CRITICALITY STUDIES—measurement of slab-shaped plutonium nitrate ($Pu(NO_3)_4$), description of; measurement of rectangular-shaped polystyrene–plutonium oxide (PuO_2) lattices, description of
PLUTONIUM OXIDES PuO_2—polystyrene–PuO_2, criticality of rectangular-shaped lattices of, analysis of (D.C.C.)

42165 (BNWL-796) DAEDALUS: A CODE TO GENERATE A LINEAR PROGRAMMING SIMULATION OF A NUCLEAR POWER ECONOMY. Neef, W. I. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

The DAEDALUS code is designed to incorporate the detailed characteristics of individual reactor types into the projected future of an expanding power industry. These characteristics are then used in a linear programming format to determine the combination of reactors producing the optimum value of some overall objective function, such as minimum cost of power or minimum fuel requirement. The reactor characteristics used in DAEDALUS are the power level, operating history, and the impact of the reactor on various materials requirements. The output from the code and the input and calculations required to generate this output are discussed. (H.D.R.)

42166 (BNWL-796(App.)) DAEDALUS: A CODE TO GENERATE A LINEAR PROGRAMMING SIMULATION OF A NUCLEAR POWER ECONOMY. Neef, W. I. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 53p. Dep. CFSTI.

A complete description of the DAEDALUS-code is given. Input and output formats are shown. A sample problem is solved. (M.L.S.)

42167 (BNWL-822) CAPCOST: A PROGRAM TO CALCULATE ESCALATED NUCLEAR POWER PLANT CAPITAL COSTS. Shank, T. A.; Kelley, E. L. Jr.; Burnham, J. B. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 18p. Dep. CFSTI.

A complete description of the CAPCOST computer program is given. The program will estimate total and component nuclear plant costs of any size light water reactor. Composite reactor construction cost data from 38 light water plants contracted in 1966 and 1967 are used as calculation bases; labor and material escalation factors are used to determine costs. Construction data are included for 75 U. S. cities. Input instructions and a program listing are included. (M.L.S.)

42168 (BNWL-SA-2002) FUTURE PROBLEMS IN SHIPPING IRRADIATED FAST REACTOR FUELS. Bloomfield, D. E.; Brown, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 25, 1968. Contract AT(45-1)-1830. 14p. (CONF-681001-1). Dep. CFSTI.

From 2nd International Symposium on Packaging and Transportation of Radioactive Materials, Gatlinburg, Tenn.

Because of different fuel characteristics and properties, shipment of irradiated fast reactor fuels presents a much more challenging and complicated problem than thermal reactor fuels. The much higher specific power and about two orders of magnitude higher flux result in significantly higher decay heat rates which present difficult problems in shipping cask designs. Water may not be a satisfactory primary coolant and superior coolants like liquid Na, other low melting point alloys, or solid metallic particles may have to be used. Improved cask fins and use of cask secondary forced coolant loops may be required. Fast reactor fuel materials and fuel element designs, unlike those of thermal fuels, vary widely in composition, components, arrangements, and configuration. The lack of standardized designs presents unique problems and uncertainties in the design and utilization of fast reactor shipping casks. (auth)

42169 (BNWL-SA-2027) EFFECTS OF STEAM-ELECTRIC PLANTS. Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 8p. (CONF-680907-1). Dep. CFSTI.

From Conference of Research Needs, Pullman, Wash.

A compilation of the basic heat rejection systems, an estimate of the present costs of various systems, and expected trends in plant technical requirements for potential heat rejection systems development are presented. Comparisons of four types of systems are presented: Nuclear Light Water Rankine; Brayton; Nuclear LMFBR or HTGR Rankine; and Fossil Rankine. (D.C.C.)

42170 (BW-67-2(App.)(Vol.1)) FULL SIZE STEAM GENERATOR GENERAL STRESS CALCULATIONS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 380p. Dep. CFSTI.

Detailed calculations of the work on Na-heated steam generator development reported in BW-67-2, Volumes 1 and 2, and Addendum BW-67-2a are included in 13 volumes of appendices. The preliminary design of the full-size steam generator is of a size that three steam generators will produce steam to drive a 1000 MW(e) turbine. Specifications of the design unit are: 1050°F steam temperature, 2400 psi outlet steam pressure, 1140°F Na temperature in, 650°F Na temperature out, use of Croloy 2¼ for boiler section construction, and use of Type 316 stainless steel for superheat section construction. Separate volumes contain stress calculations for the full-size generator, tube sheets, reheater, boiler inlet and outlet headers, superheater inlet and outlet headers, and the Na inlet nozzle. (H.D.R.)

42171 (BW-67-2(App.)(Vol.2)) FULL SIZE STEAM GENERATOR GENERAL STRESS CALCULATIONS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 300p. Dep. CFSTI.

42172 (BW-67-2(App.)(Vol.3)) TEMA; CALCULATIONS, NOZZLE LOADING CALCULATIONS AND STEADY STATE CALCULATIONS FOR TUBE SHEETS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 143p. Dep. CFSTI.

42173 (BW-67-2(App.)(Vol.4)) REHEATER GENERAL STRESS CALCULATIONS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 185p. Dep. CFSTI.

42174 (BW-67-2(App.)(Vol.5)) BOILER INLET HEADER STEADY STATE AND THERMAL TRANSIENT STRESS ANALYSIS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 190p. Dep. CFSTI.

42175 (BW-67-2(App.)(Vol.6)) BOILER OUTLET HEADER STEADY STATE AND THERMAL TRANSIENT STRESS ANALYSIS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 25p. Dep. CFSTI.

42176 (BW-67-2(App.)(Vol.7)) SUPERHEATER INLET HEADER STEADY STATE AND THERMAL TRANSIENT STRESS ANALYSIS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 160p. Dep. CFSTI.

42177 (BW-67-2(App.)(Vol.8)) SUPERHEATER OUTLET HEADER STEADY STATE STRESS ANALYSIS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 69p. Dep. CFSTI.

42178 (BW-67-2(App.)(Vol.9)) SUPERHEATER OUTLET HEADER THERMAL TRANSIENT STRESS ANALYSIS (TRANSIENT NO. 7). (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 44p. Dep. CFSTI.

42179 (BW-67-2(App.)(Vol.10)) NA INLET NOZZLE FATIGUE ANALYSIS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 37p. Dep. CFSTI.

42180 (BW-67-2(App.)(Vol.11)) NA INLET NOZZLE STEADY STATE STRESS ANALYSIS. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 109p. Dep. CFSTI.

42181 (BW-67-2(App.)(Vol.12)) NA INLET NOZZLE THERMAL TRANSIENT STRESS ANALYSIS (TRANSIENT NO. 7). (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 108p. Dep. CFSTI.

42182 (BW-67-2(App.)(Vol.13)) FUNCTIONAL ENGINEERING. (Babcock and Wilcox Co., Barberton, Ohio). [1964]. Contract AT(11-1)-1280. 175p. Dep. CFSTI.

42183 (CEA-R-3499) STUDY OF THE POSSIBILITIES OF A COMPENSATION SYSTEM DRIVEN BY A COMPUTER FOR OPTIMIZING THE OPERATION OF A NUCLEAR REACTOR. Wagner, Karel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1968. 49p. (In French). Dep.

Control rod-induced power perturbations in heavy water power reactors are analyzed. Optimization of reactor power by compensation for perturbations is discussed. Use of a computer for determination of optimum control rod configuration is described. (M.L.S.)

42184 (DOCKET-50255-10) [PALISADES PLANT]. [Preliminary Description and Safety Analysis Report], Amendment 2. (Consumers Power Co., Jackson, Mich.). Sept. 13, 1966. 57p. Dep. CFSTI.

Transient temperature conditions for the Palisades Power Reactor are described. Peak heat flux factor, peak enthalpy rise factors, and peak axial flux factors are given. All hot channel data are tabulated. Parameters for a rod ejection accident are tabulated; consequences are analysed. The basis for selection of startup accident parameters is evaluated. Effects of simultaneous loss of power to all coolant pumps are analysed. (M.L.S.)

42185 (DOCKET-50267-12) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 6. (Public Service Co. of Colorado, Denver). Oct. 30, 1967. 147p. Dep. CFSTI.

Additional information on the quality control program for the prestressed concrete reactor vessel (PCRV) is detailed. An analysis of boron migration in-core during a core heatup accident is given. Effects of loss of forced circulation and loss of water cooling to core support floor are analysed. Allowable stresses for PCRV internal steel structures are tabulated. A failure analysis for the helium circulators is given. The moisture sampling system is described. Shutdown instruments are listed. The integrity of the PCRV liner, under load conditions, is evaluated. Detailed data on the PCRV are given. (M.L.S.)

42186 (DOCKET-50313-5) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, [Amendment 2] Amendment 1. (Arkansas Power and Light Co., Little Rock). Feb. 19, 1968. 175p. Dep. CFSTI.

Revised information on the Russellville Power Reactor is given under the following broad subjects: site and environment, reactor design, reactor coolant system, containment system, engineered safeguards, instrumentation and control systems, electrical systems, auxiliary and emergency systems, steam and power conversion system, and standby safeguards analysis. A safety investigation report on the Dardanelle lock and dam on the Arkansas River is included. (M.L.S.)

42187 (DOCKET-50313-8) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, Amendment 5, Suppl. 5. (Arkansas Power and Light Co., Little Rock). July 10, 1968. 74p. Dep. CFSTI.

Information on the structural design of the Russellville Power Reactor containment building is given; the prestressing system is detailed; loads at transfer of prestress are analyzed. Analytical methods for calculating shear stress limits and shear reinforcing are given. Membrane strains are calculated for the liner plate under accident conditions. Design criteria for penetrations are given. (M.L.S.)

42188 (GAMD-7903) PEACH BOTTOM INITIAL POWER PLANT PERFORMANCE (RESULTS OF POSTCONSTRUCTION R AND D TEST PROCEDURES DE-1, GE-1, GO-2, DP-1, AND GP-10). Kantor, M. E.; Menzel, H. F.; Schlicht, R. W. (Gulf

General Atomic, Inc., San Diego, Calif.). Mar. 29, 1968. Contract AT(04-3)-314. 78p. Dep. CFSTI.

A description of the approach-to-power tests for the Peach Bottom Power Reactor, Unit 1 is given. Reactor plant operating limits are tabulated. Primary loop and steam generator analyses are given; overall plant efficiency is evaluated. The power level measurements are described; ranges of the ^{10}B-proportional counter, compensated ion chambers, and uncompensated ion chambers are given. Reactor core and metal temperature measurements are described. Instrumentation for and measurements in the primary loop, steam generator, and turbine-generator are discussed. Coolant loop flow calibration data are given. Compressor and steam generator performance are evaluated. All are shown graphically. (M.L.S.)

42189 (GAMD-8423) ANALYSIS OF THE MULTICOLUMN FLOW DISTRIBUTION TEST DATA. Malek, G. J.; Hausermann, R. (Gulf General Atomic, Inc., San Diego, Calif.). June 5, 1968. Contract AT(04-3)-633. 68p. Dep. CFSTI.

Coolant flow characteristics of an orificed core for a high temperature gas cooled reactor of the Fort St. Vrain Power Reactor type are determined. Flow and pressure distribution measurements in the simulated portion of the core, including effects of crossflow, are described. Tests, run with and without simulation of graphite contraction, are detailed; experimental apparatus is described. Core mockup parameters are listed. Results of the multicolumn flow distribution tests are summarized; data are presented graphically. An analytical model is derived for correlating flow model tests. (M.L.S.)

42190 (GEAP-5184) FLOW DISTRIBUTION MEASUREMENTS IN A 3-SCALE MODEL OF THE SEFOR FUEL BUNDLE. Williams, R. F.; Polomik, E. E.; Russell, C. E. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Apr. 1968. Contract AT(04-3)-540. 88p. Dep. CFSTI.

Mass flow distribution in the SEFOR fuel bundle was determined by means of velocity measurements in a 3-scale model, using water to simulate the hydraulic parameters of the reactor. Velocity measurements were obtained by means of a radially traversing pitot tube mounted in one of the simulated fuel rods. This rod could be rotated to any angular position desired for a velocity transverse, and the pitot tube could be mounted at any one of four elevations. Data were obtained at each elevation to determine the effect of changes in rod pitch. The effects caused by rod tilt, unequal rod spacing, and changes in Reynolds' number were also investigated. Changes in rod pitch had the most significant effect on flow distribution. Reynolds' number had a negligible effect in the range tested (N_{Re} = 43900 to 66000). Measured data were found to agree qualitatively with predicted data. Thus, configuration changes made after the tests were run could be evaluated without additional testing. The measured and predicted data were used to choose the optimum rod pitch with respect to thermal bowing gradients in SEFOR. (auth)

42191 (IN-1169) APPLICABILITY OF CONVENTIONAL PROTECTIVE COATINGS TO REACTOR CONTAINMENT BUILDINGS. Newby, B. J. (Idaho Nuclear Corp., Idaho Falls). June 1968. Contract AT(10-1)-1230. 75p. Dep. CFSTI.

Commercially available protective coatings were tested for their applicability in the containment buildings of boiling and pressurized water power reactors with particular emphasis on conditions present after a loss-of-coolant nuclear accident, such as the LOFT. Characteristics evaluated included resistance to pressurized steam, radiation, abrasion, and chemical decontaminating reagents; elasticity; ease of decontamination from fission products; and compatibility with aged primers. Coatings possessing desirable values for these characteristics were found; the complete results of the evaluations are reported. (auth)

42192 (INR-903) APPROXIMATE DETERMINATION OF THE OPTIMUM MEAN TEMPERATURE AT WHICH HEAT IS SUPPLIED TO THE WORKING FLUID IN NUCLEAR POWER STATION. Sikora, W. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 18p. (In Polish). Dep.

The method of approximate determination of the optimum mean temperature at which heat is supplied to the working fluid in the dual cycle nuclear power stations is presented. The exception applies to stations with boiling water reactors. The method is based on the evaluation of the participations of the fuel costs and capital charges in the anticipated total production costs of generating power. In the nuclear power stations in which turbines work with saturated steam, the calculation of the mean temperature at which heat is supplied to the working fluid, permits to calculate the initial conditions of the steam temperature and pressure, for a given feed water temperature. In the dual cycle nuclear power stations in which the turbines work with superheated steam, it is necessary moreover to calculate either the initial temperature or initial pressure of the steam, in order to determine the initial steam conditions. (auth)

42193 (JPRS-45814) DEVELOPMENT OF ATOMIC POWER ENGINEERING. Translated from pp 162-73 of Elektrifikatsiya SSSR, 1917-1967, Energiya, Moscow, 1967. 17p. CFSTI.

The development of nuclear power in the USSR is summarized. Descriptions of the Nououoronezh and Beloyarsk Power Reactors are given; the fast power reactor at Shevchenko (BN-350) is described, also. The proposed Bilibiu Power Reactor is discussed. (M.L.S.)

42194 (MSAR-68-77) THE EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, January-March 1968. (MSA Research Corp., Evans City, Pa.). May 1968. Contract AT(11-1)-765. 91p. Dep. CFSTI.

The corrosive effects of high temperature liquid Na on structural materials for the LMFBR are analyzed. Type 304 and Type 316 stainless steel are submitted to high-O_2 and -C liquid Na at 1200 and 1400°F. The effects of the liquid Na on tensile properties of the stainless steel samples are described. Surface tension measurements for pure liquid Na are presented. (D.C.C.)

42195 (NP-tr-1682) RECENT EXPERIENCES IN THE OPERATION OF RAPSODIE. Denielou, G. Translated for Atomic Power Development Associates, Inc., Detroit, Mich., from Energ. Nucl. (Paris), 10: 22-8(1968). 14p. Dep.

A power history of Rapsodie is given; reactor reliability is discussed. Predicted and operational characteristics are compared. Dynamic and kinetic characteristics are described. Some maintenance and alterations problems encountered in working with sodium systems are outlined. (M.L.S.)

42196 (NRL-6739) NOTCH DUCTILITY AND TENSILE PROPERTY EVALUATION OF THE PM-2A REACTOR PRESSURE VESSEL. Serpan, Charles Z. Jr. (Naval Research Lab., Washington, D. C.). Apr. 22, 1968. Contract AT(49-5)-2110. 20p. Dep. CFSTI.

Following the pressurization-to-failure testing of the PM-2A reactor pressure vessel, several sections of steel were removed from the vessel wall in a region adjacent to the artificial defect. Charpy V-notch and tension test specimens machined from one of these sections have been evaluated. The irradiated-condition 30 ft-lb transition temperatures for the ¼-thickness (nearest to the core) and ¾-thickness locations in the vessel wall were +115°F and +55°F, respectively, for measured fission-spectrum fluences of 7.3 and 4.0×10^{18} n/cm^2 (>1 MeV). The ¼-thickness properties and fluence most nearly represented those at the tip of the artificial defect. The 0.2% yield strength for the ¼-thickness location was 97,620 psi at −20°F (failure temperature) and 92,200 psi at +72°F (temperature at time of acid-sharpening treatment of artificial defect). Significant uniform elongation, reduction of area, and elongation per 1 in. were retained by the steel. An assessment of the stress, temperature, and flaw-size conditions for the PM-2A failure, as indexed by the irradiated-condition mechanical properties, indicates that the failure is in agreement with the generalized fracture analysis diagram. (auth)

42197 (NSJ-tr-112) STUDIES FOR SAFETY ANALYSIS OF LOSS-OF-COOLANT ACCIDENTS IN LIGHT-WATER POWER REACTORS. Fujie, Hideo; Yamanouchi, Atsuo; Sagawa, Norihiko; Ogasawara, Hideo; Tagami, Takashi. Translated from Nippon Kikai Gakkaishi, 69: 1068-76(Aug. 1966). 22p. Dep.

In order to establish the method of safety analysis for loss-of-coolant accidents in light-water power reactors, several factors which affect the amount of fission products released from the reactor plant to the atmosphere were investigated experimentally. The temperature changes of the sheathed heaters, assembled in the same arrangement as for the JPDR fuel assembly, after start of the spray, were measured, and a method was obtained for calculating the temperature change of the fuel rods after the loss-of-coolant. The flow rates of saturated water through the orifices of 10 ~ 70 mm diameter from the pressure vessel were measured and compared with Moody's theory. The calculated values from this theory need some correction factors depending on the orifice area to agree with the measured ones. Heat transfer coefficients on the container walls were obtained with measuring devices installed in the model container and the relationship between the heat transfer coefficient and the lapse of time, and the container inner-pressure were obtained. The relation between the container spray cooling-efficiency and the inner-pressure was obtained from experiments using the model container. (auth)

42198 (NSJ-tr-114) ADVANCED THERMAL REACTORS AND FUEL CYCLE. Mochizuki, Hiroji; Tanaka, Ryokichi. Translated from FAPIG (Tokyo), 40: 20-5(Apr. 1966). 13p. Dep.

The fuel cycle for advanced thermal reactors was examined for the expected, future installation of nuclear power stations in Japan. In a comparative study of heavy-water reactors, the fuel economic advantage of French EL-500 type gas-cooled heavy-water moderated reactors with Be cladding was investigated. By predicting the time when ATRs and fast reactors will be introduced in the nation's power-supply system according to the power reactor development program, the U demand was studied for the various combinations of ATRs and the fast reactor. As the result, it was found that a cumulative total of 90,000 ~ 100,000 tons of U_3O_8 could be saved by 2010 by going the course through the stage of switching to EL-500 type ATRs, in comparison with the direct course from light-water reactors to fast reactors. Further, it was clarified that it was more advantageous to recycle some of the Pu produced in thermal reactors to ATRs and light-water reactors, than stockpiling it all for the fast reactors. (auth)

42199 (NYO-3930-1) LIQUID METAL BEARINGS TECHNOLOGY FOR LARGE HIGH TEMPERATURE SODIUM ROTATING MACHINERY. First Quarterly Progress Report, February 1, 1968–April 30, 1968. (Mechanical Technology Inc., Latham, N. Y.). Contract AT(30-1)-3930. 37p. Dep. CFSTI.

The identification of desired bearing configurations for liquid metal-cooled reactor coolant pumps and auxiliaries is described. Compilation of design data for optimum bearing configurations is presented. Testing the validity of design data is accomplished by a high temperature sodium test facility using a three-bearing-type rotor design. The development of accurate and reliable film thickness and film pressure measurement transducers for hot sodium environment is described. (D.C.C.)

42200 (ORNL-4200) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1967. Savolainen, Ann W. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 255p. Dep. CFSTI.

REACTORS, GAS-COOLED—development program for HTGR, analysis of ORNL April to September 1967

REACTOR FUELS—fabrication of phenolic resin-bonded silicon carbide (SiC)-coated uranium oxide (UO_2) and thorium oxide (ThO_2) spheres, description of

REACTOR FUEL ELEMENTS—fabrication of carbon-containing resin-bonded stick-type silicon carbide (SiC)-coated uranium oxide (UO_2) and thorium oxide (ThO_2), description of; mechanical properties of carbon-containing resin-bonded stick-type silicon carbide (SiC)-coated uranium oxide (UO_2) and thorium oxide (ThO_2), effects of carbonization and curing on

URANIUM OXIDES UO_2—fuel fabrication of resin-bonded silicon carbide (SiC)-coated spheres, description of; conversion to uranium carbide (UC) of, mechanisms and kinetics of; radiation effects on mechanical properties of silicon carbide (SiC)-coated and uncoated, analysis of neutron; fission gas release at 1700 and 2000°C for single-crystal, analysis of; PuO_2–UO_2, radiation effects on mechanical properties of Hastelloy X- and Type 316 stainless steel-clad, analysis of fast neutron

THORIUM OXIDES—fuel fabrication of resin-bonded silicon carbide (SiC)-coated spheres, description of

SILICON CARBIDES—coating fabrication of resin-bonded uranium oxide (UO_2) and thorium oxide (ThO_2) spheres, description of

CARBON—coating of plutonium oxide (PuO_2) spheres by pyrolytic, effects of temperature on; oxidation by water vapor of fuels with coatings of pyrolytic, analysis at 1000 and 1200°C of

PLUTONIUM OXIDES PuO_2—fuel fabrication of pyrolytic-carbon-coated spheres of, effects of temperature on

URANIUM CARBIDES—conversion from uranium oxide (UO_2) to, mechanisms and kinetics of; radiation effects on mechanical properties of uncoated, analysis of neutron; fission gas release at 1700 and 2000°C for silicon carbide (SiC)-coated, analysis of

STRONTIUM ISOTOPES Sr-89, YTTRIUM ISOTOPES Y-91, RUTHENIUM ISOTOPES Ru-103, CESIUM ISOTOPES Cs-137, CERIUM ISOTOPES Ce-144, BARIUM ISOTOPES Ba-140, IODINE ISOTOPES I-131—fission product release from silicon carbide (SiC)-coated uranium carbide (UC_2) and uranium oxide (UO_2) at 1700 and 2000°C, analysis of

REACTOR SAFETY—steam corrosion of fuels, effects of pyrolytic carbon coatings on

PRESSURE VESSELS—mechanical properties of prestressed concrete, model analysis of

HASTELLOY X—radiation effects on mechanical properties of plutonium oxide (PuO_2)–uranium oxide (UO_2) fuel cladding of, analysis of fast neutron

STAINLESS STEEL—radiation effects on mechanical properties of plutonium oxide (PuO_2)–uranium oxide (UO_2) fuel cladding of Type 316, analysis of fast neutron

NEUTRONS, FAST—effects on mechanical properties of Hastelloy X- and Type 316 stainless steel-clad plutonium oxide (PuO_2)–uranium oxide (UO_2) fuel elements, analysis of. (D.L.C.)

42201 (ORNL-4269) OXIDATION OF BONDED COATED-PARTICLE FUEL COMPACTS BY STEAM. Blood, C. M.; Hebert, G. M.; Overholser, L. G. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 31p. Dep. CFSTI.

Fuel compacts, consisting of bonded beds of pyrolytic-C coated fuel particles encased in graphite, were oxidized at 1000, 1100, and 1200°C using He-steam mixtures having partial pressures of steam of 20, 70, or 150 torr and a total pressure of 1 atm. Overall reaction rates and BET surface areas were determined at various burnoffs and the oxidized fuel compacts examined for possible damage to the graphite containers, the bonding materials, and the pyrolytic C coatings on the fuel particles. Fuel compacts oxidized to burnoffs of 6 and 14 wt. % experienced no significant damage to the pyrolytic C coatings and only limited attack of graphite containers. A fuel compact oxidized to ~50 wt % burnoff was severely damaged resulting, however, in failure of only 0.2% of the coatings. Graphite containers were found to be less effective in protecting the bonded bed against damage from oxidation at 1000°C than at higher temperatures. (auth)

42202 (ORNL-NSIC-23) POTENTIAL METAL–WATER REACTIONS IN LIGHT-WATER-COOLED POWER REACTORS. McLain, Howard A. (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 201p. Dep. CFSTI.

The available data regarding the role of chemical reactions in the unlikely event of a light-water power reactor accident were collated and reviewed. These reactions must be considered as only one of the many aspects of a reactor accident, and only by considering an integral model of the accident can they be assessed realistically. Compared with the situation regarding the definition and mathematical simulation of the reactor accident, the basic kinetics of the chemical reactions are well understood. Contributions of the metal-water reaction to the consequences of a nuclear-excursion accident appear to be minor compared with the other aspects of these accidents. In a loss-of-coolant accident, prompt initiation of emergency core-cooling systems would limit the amount of metal-water reaction to a low value. However, possible fragmentation of fuel pins having chemically reacted cladding makes it difficult to interpret quantitatively the criterion that the cladding metal–water reaction is to be limited to negligible amounts. Without the use of emergency core-cooling systems, it appears that the amount of metal reacted prior to the melting of the reactor core would be between 25 and 50%. H_2 explosions are not usually considered credible, since H_2 produced by the metal–water reaction is assumed to be below its flammability limit or is assumed to burn upon entry into the containment vessel. Although there is much information to back up these assumptions, more work should be done regarding the detonation limits of H_2–air–steam mixtures and the possible pocketing of H_2 within containment vessels. 206 references. (auth)

42203 (ORNL-NSIC-45) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE-14. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 501p. Dep. CFSTI.

A bibliography on nuclear safety is given. Material is categorized according to: General Safety Criteria; Siting of Nuclear Facilities; Transportation and Handling of Radioactive Materials; Aerospace Safety; Accident Analysis; Reactor Transients, Kinetics, and Stability; Fission Product Release, Transport, and Removal; Sources of Energy Release under Accident Conditions; Nuclear Instrumentation, Control, and Safety Systems; Electrical Power Systems; Containment of Nuclear Facilities; Plant Safety Features; Radiochemical Plant Safety; Radionuclide Release and Movement in the Environment; Environmental Surveys, Monitoring and Radiation Exposure of Man; Meteorological Considerations; Operational Safety and Experience; and Safety Analysis and Design Reports. (M.L.S.)

42204 (RT/ING-(68)7) REMARKS ON SOME ASPECTS OF FBR THERMAL AND HYDRAULIC ANALYSIS: CORE OPTIMIZATION, SAFETY AND SODIUM BOILING. Noyes, R. C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 28p. (PRV-R-(67)2). Dep.

Summarized is a seminar presented at the Casaccia Nuclear Studies Center and Bologna Computer Center in January 1967. The seminar included a survey on: fast breeder core optimization methods; fast breeder reactor safety problems and accidents analysis methods; sodium boiling aspects such as steady state and transient experiments; theories and models; results of voiding studies; some possible effects of sodium boiling research on fast breeder core design. (auth)

42205 (RT/ING–(68)10) A DISCUSSION OF METHODS FOR THEORETICAL ANALYSIS OF COOLANT EJECTION IN FBR's, INCLUDING A DESCRIPTION OF THE ETNA CODE. Noyes, R. C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 39p. (PRV-R–(68)6). Dep.

A description of the ETNA-code for transient two-phase flow analysis for fast breeder reactor safety is given. The theoretical bases for the program are detailed. The equations and methods of calculation are given. Basic flow diagrams and program format are included. (M.L.S.)

42206 (SNE–40) INVESTIGATION OF THE USE OF AQUEOUS SOLUTIONS AS EMERGENCY COOLANTS. Second Quarterly Report. McCullough, C. Rogers; Brown, Gilbert M.; Hancock, R. P.; Maxwell, W. A.; Turner, S. E. (Southern Nuclear Engineering, Inc., Dunedin, Fla.). July 1, 1968. Contract AT(40-1)-3749. 91p. Dep. CFSTI.

The results of a literature search are presented for additive candidates and additive solution properties, screening tests to narrow the candidate list, and single rod-heated enclosure deluging and flooding tests. The screening tests are performed by submerging at 1600°F, 25000 Btu/(hr)(ft^2) Zircaloy clad resistance heater in a vertical tube filled with the boiling solution. The single rod-heated enclosure tests consist of a single, six-foot long, Zircaloy-clad resistance heater vertically mounted in a 1.5 in. pipe which is heated. The coolant is injected into the enclosure at the top for deluge, or injected at the bottom for flooding. (D.C.C.)

42207 (SWRI–1228-P-11-6) SURVEILLANCE AND INSPECTION PROGRAMS FOR LACBWR REACTOR PRESSURE VESSEL AND ASSOCIATED PIPING AND EQUIPMENT RADIATION SURVEILLANCE. Topical Report No. 3. Norris, E. B. (Southwest Research Inst., San Antonio, Tex.). June 14, 1968. Contract AT(11-1)-1228. 38p. Dep. CFSTI.

The pressure vessel material surveillance program for the La Crosse Boiling Water Reactor has been reviewed both with respect to dosimetry and removal and testing schedule. Recommendations have been made to alter the removal and testing schedule slightly, but it was concluded that the dosimetry is adequate for the intended purpose. (auth)

42208 (SWRI–1228-P-11-7) SURVEILLANCE AND INSPECTION PROGRAMS FOR LACBWR REACTOR PRESSURE VESSEL AND ASSOCIATED PIPING AND EQUIPMENT INSPECTION PROGRAM DEVELOPMENT. Topical Report No. 4. Wylie, Robert D. (Southwest Research Inst., San Antonio, Tex.). July 8, 1968. Contract AT(11-1)-1228. 22p. Dep. CFSTI.

The inspection program for the La Crosse Boiling Water Reactor is described. Inspection points are tabulated; relative ease or difficulty of access is evaluated. Inspection points include: pressure vessel closure head, pressure vessel and intervals, forced circulation piping systems, and steam lines. A schedule of inspection is given. (M.L.S.)

42209 (SWRI–1228-P-11-8) SURVEILLANCE AND INSPECTION PROGRAMS FOR LACBWR REACTOR PRESSURE VESSEL AND ASSOCIATED PIPING AND EQUIPMENT INSPECTION EQUIPMENT. Topical Report No. 5. Howell, R. C.; Lautzenheiser, C. E. (Southwest Research Inst., San Antonio, Tex.). July 9, 1968. Contract AT(11-1)-1228. 21p. Dep. CFSTI.

In-service inspection of nuclear power plant components requires custom, automated equipment. This equipment provides reproducible data for later comparisons as well as protection from radiation for inspection personnel. Ultrasonic devices can adequately perform the inspections, enabling permanent records of periodic surveillance. Most of the inspection units have basic capabilities and are designed to examine areas of high stress levels. The unit conceived for internal inspection of forced-circulation outlet nozzles is more complex. Internal inspection of both the steam and forced-circulation nozzles will necessitate minor revision to certain reactor internals. (auth)

42210 (TID–24564) MONTHLY REPORT NO. 12, MAY 1968. Report on UKAEA Reactor Safety Course No. 6, May 6–May 31, 1968. Stachura, Stanley J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). 45p. Dep. CFSTI.

A complete description of the May 1968 UKAEA reactor safety course is given. The gas-cooled and water-reactor safety programs are discussed; the fast-reactor safety program is detailed. The role of prototype fast reactors in reactor safety is described. Two lectures on a survey of safety problems of fast reactors and operating experience with the Dounreay Fast Reactor are included. (M.L.S.)

42211 (TRG-Report–1693) EXPERIENCE WITH AND POTENTIAL OF GAS-COOLED REACTORS IN THE U.K. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 31p. Dep.

U.K. experience with the commercial Magnox stations is described. The role of the Windscale experimental AGR in providing information on performance of reactor materials, and on safety and control problems, is also discussed. The essential features and economic and technical advantages of the C.E.G.B.'s commercial AGR stations are examined, and the various possibilities of development of these stations, which may result from current technical developments in materials and design, are considered. (UK)

42212 (TRG-Report–1695) NUCLEAR POWER DEVELOPMENT PROSPECTS IN THE NINETEEN-SEVENTIES. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 30p. Dep. CFSTI. UK 6s0d.

Gas-cooled and water cooled nuclear power stations operating in U.K., U.S.A. and Canada are assessed. Those under construction are also reviewed, and major advances in design are described for AGR stations, the SGHWR, and the light-water reactors being built in U.S.A. The prospects for development of alternative types of gas-cooled thermal reactors and of fast reactors are examined. Uses of plutonium produced in thermal reactors are discussed in terms of the world market and its application as a fuel for thermal or fast-breeder reactors. (UK)

42213 (WCAP–3374-5) FOURTH QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1965, FOR THE SUPERCRITICAL TECHNOLOGY PROGRAM. Patterson, J. F.; Boyd, W. S. (comps. and eds.) (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3374. 59p. Dep. CFSTI.

Design and fabrication program of a supercritical water-cooled in-pile loop in the Saxton Power Reactor is described. Fabrication of two fuel assemblies by pellets and vibratory compaction is also described. Fuel rods containing UO_2 pellets are clad in Incoloy 800. Fuel rods that are vibratory compacted and swaged are clad in 16 Cr–20Ni–stainless steel. (D.C.C.)

42214 (WCAP–3374-8) SUPERCRITICAL TECHNOLOGY PROGRAM. Final Report. Patterson, J. F. (comp. and ed.) (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1968. Contract AT(30-1)-3374. 236p. Dep. CFSTI.

The objectives of the supercritical technology program were to: (1) Build and install a supercritical water-cooled, in-pile, fuel testing loop. (2) Demonstrate the feasibility of collapsed clad fuel elements in a reactor environment, cooled by supercritical water. (3) Evaluate the design of the fuel elements by post-irradiation examination. (4) Evaluate loop performance by analyzing operating data. Two fuel assemblies manufactured by different methods (pellets and vibratory compaction) were to be tested. Fuel rods containing pellets were clad with Incoloy 800, while those which are vibratory compacted and swaged were clad with 16 Cr–20 Ni stainless steel. An existing loop design and large number of loop components previously purchased by Westinghouse have been turned over to the AEC under the terms of the contract. The design of the loop is complete and the remainder of the components have been purchased under the contract. Fuel assembly and pressure tube designs have been completed. Two pressure tubes and the first fuel assembly have been fabricated. The program was suspended on April 15, 1965 and the contract was terminated on November 3, 1965. (auth)

42215 GAS-COOLED FAST REACTOR USING COATED PARTICLE FUEL. Gratton, C. P.; Bevan, E. G.; Graham, J.; Hobday, R.; Hooper, A. T. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 7: 233–42 (July 1968).

A study is made of the way in which the coated particle fuels being developed for gas-cooled thermal reactors could be applied to a gas-cooled fast reactor (GCFR), using as a model a 1000 MW(e) unit. A fuel assembly making use of direct cooling of the fuel particles is proposed which, subject to the development of sufficiently reliable fuel particles, offers the prospects of fuel ratings and performance comparable with those of sodium-cooled fast reactors (SCFR). An assessment of certain safety issues, with particular reference to the depressurization accident, indicates that the moderate coolant pressures needed and the high temperature properties of the fuel, coupled with the prestressed concrete pressure vessel, ease many of the safety problems raised previously on gas-cooled fast reactors. (auth)

42216 BRADWELL REACTOR COOLANT CHEMISTRY. PART II. THE INFLUENCE OF COOLANT DRIER PLANT. Godfrey, W. R.; Phennah, P. J. (Central Electricity Generating

Board, Bradwell, Eng.). J. Brit. Nucl. Energy Soc., 7: 217-23 (July 1968).

Bradwell reactors are provided with drier plant for removal of water vapour from recirculating coolant gas. Long periods of operation with driers in continuous use show that this plant effectively controls the concentrations of several hydrogenous species in the coolant, through the rejection of water. Chemical analyses of liquors rejected by the driers show the presence of substantial quantities of organic acids and ammonia, synthesized within the primary circuit. Hydrogen mass balance data are used to examine the build-up of hydrogenous species in the coolant, and the concentration of tritium in coolant gas and in drier liquors is examined as a function of normal and transient reactor operation. (auth)

42217 TRITIUM FORMATION IN HELIUM-COOLED REACTORS FROM THE $^3He(n,p)^3H$ REACTION. Clarke, D. A. (Atomic Power Constructions Ltd., Sutton, Eng.). J. Brit. Nucl. Energy Soc., 7: 257-8(July 1968).

Generalized equations are derived governing the theoretical quantities of tritium formed in helium-cooled reactors from the $^3He(n,p)^3He$ reaction. Formulae are presented for tritium activity in the coolant and in water removed by the purification system. (auth)

42218 BRADWELL REACTOR COOLANT CHEMISTRY. PART III. OBSERVATIONS CONCERNING THE CHEMISTRY OF HYDROGENOUS COMPONENTS. Godfrey, W. R.; Phennah, P. J. (Central Electricity Generating Board, Eng.). J. Brit. Nucl. Energy Soc., 7: 224-32(July 1968).

Studies are described on the chemistry of hydrogen, water and methane impurities in Bradwell reactor coolant. The mutual dependence of the concentrations of hydrogenous components is established, and the nature of some of the reactions responsible for their interconversion is studied. (auth)

42219 DOUNREAY FAST REACTOR ON POWER AGAIN. Engineer, 226: 88(July 19, 1968).

A description is presented of the new techniques in leak detection, using gold and helium, which were applied in tracing the source of the liquid metal leak in the primary coolant system of the reactor. The leakage, which ceased on shutdown, was traced to a section containing the thermocouple block and was caused by a crack in a weld containing a severe alignment fault between the sections joined by the weld. Thermal stress in the area caused fatigue failure. Remote welding techniques were developed to restore the reactor to service. (UK)

42220 REGULATION AND CONTROL OF NUCLEAR POWER PLANTS. Staebler, K. (Bayernwerk AG, Munich). Neue Tech., 10: 85-92(June 1968). (In German).

The role of control techniques for the control of nuclear power stations is discussed on the basis of operation programs. A detailed description is presented of power control in PWR and BWR. Operation experiences of the Gundremmingen Power Reactor are presented. The control concept of a gas-cooled reactor is discussed on the basis of the KKN-reactor. (auth)

42221 AUXILIARY APPARATUS FOR NUCLEAR POWER PLANTS. Boegh, P. (Motor-Columbus AG, Baden, Switzerland). Neue Tech., 10: 95-101(June 1968). (In German).

The main data of demineralizers, tanks, heat exchangers, and fuel handling equipment for auxiliary systems of nuclear power plants with water-cooled reactors are specified. The equipment and systems are described. (auth)

42222 AUXILIARY MACHINES FOR NUCLEAR POWER PLANTS. Dozinel, P. (Societe de Traction et d'Electricite, Brussels). Neue Tech., 10: 102-11(June 1968). (In French).

The safety requirements, the availability considerations and the access possibilities are reviewed in a general manner. A brief description of the auxiliary pieces of equipment, pumps, fans, diesel generators, and handling machines, defines their major characteristics. The new requirements imposed to the manufacturers by the nuclear energy are described. (auth)

42223 GAS CIRCULATOR BEARINGS. Baumann, H. (Brown, Boveri and Cie., Ltd., Baden, Switzerland). Neue Tech., 10: 112-17(June 1968). (In German).

The demand for a very high degree of leak tightness of the helium-cooled High-Temperature Reactor requires completely encapsulated circulators. This encapsulation is in line with the new reactor safety philosophy to include the circulators in the prestressed-concrete pressure vessel. From circulators with gas bearings of 70 to 190 kW, the development of circulators up to 2800 kW power input for a HTR of 400 MW(e) is attempted. (auth)

42224 VALVES FOR NUCLEAR REACTORS. Boyne, H. (Motor-Columbus AG, Baden, Switzerland). Neue Tech., 10: 117-22(June 1968). (In German).

The special status of the valving for nuclear power plants is described. References are given concerning the design, selection, and inspection of materials. Due to the large flow diameters necessary and to the pressure levels given, valving earmarked for use within the primary loop generally requires a new design concept. For the auxiliary and branched-off systems on the other hand, it is possible to utilize approved standard valving with only minor modifications. (auth)

42225 CANDU–BLW. Pon, G. A. Nucl. Eng., 13: 519-20(June 1968).

Progress on the design and construction of the 250 MW(e) Gentilly power station is reported. Modifications to the schedule and costs are discussed. (UK)

42226 ONTARIO HYDRO'S NUCLEAR ACTIVITIES. Nucl. Eng., 13: 502-3(June 1968).

The current commitments, and considerations involved in meeting a forecast demand increase of 9,700 MW(e) in the next decade, are reviewed. With exploitable hydro sites exhausted, nuclear power will play an increasingly important role. (UK)

42227 NUCLEAR ENERGY IN THE WORLD AND IN POLAND. Kuchowicz, B. Wszechswiat, 7: 194-5(1967). (In Polish).

Data characterizing the rise of nuclear power in the world, especially in the neighbour states, are given. The main lines of the preparations in Poland in this direction are presented. (UK)

42228 SPECIAL CHARACTERISTICS OF TURBINES FOR "GRAPHITE-GAS" POWER REACTORS. Hoffmann, G. Atompraxis, 14: 105-7(Mar. 1968). (In German).

The power reactors which constitute the basis of French nuclear equipment use natural uranium. They are moderated with graphite and cooled with carbon dioxide. Described are the special features of the turbines used with this type of reactor by mainly considering the 250 MW, 3000 r.p.m. turbines of the Chinon and St. Laurent des Eaux Power Plants. (auth)

42229 UKAEA STEAM GENERATING HEAVY WATER REACTOR. Steam Heat. Eng., 37: 18-25(May 1968).

The SGHWR is described, with particular attention to the engineering aspects. Pumps, seals, valves, and piping used in the coolant circuit, the shutdown system, and the containment system are described. Special features incorporated in the refuelling machine, designed for both on-load and off-load operation, and in the turbine generator and condenser are discussed. Major contractors are listed. (UK)

42230 PRESSURE TESTS ON CZECH GCHWR MODEL PRESSURE VESSEL. Urban, Antonin (Skoda, Plzen, Czech.). Nucl. Eng., 13: 580-5(July 1968).

The vessel, designed for CO_2 at 65 kg/cm^2 and for an input temperature of 120°C, is welded from rings and segments of mild steel to form a tall cylinder with hemispherical ends. Pressure testing is conducted on a shortened full-scale model with full size end caps. Results of bolt tightening tests are observed and stresses induced during heating are measured. A description is given of the equipment and instrumentation used for the hydrostatic test. The procedure is followed, stage by stage, by use of a computer. (UK)

42231 THREE GENERATIONS OF NUCLEAR POWER STATIONS. Bainbridge, G. R.; Marsham, T. N. (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Inst. Fuel, 41: 280-8(July 1968).

The design and construction work for three generations of nuclear power stations is well advanced in the United Kingdom. The first generation—5,000 MW(e) of Magnox gas-cooled reactors burning natural uranium—will be completed by 1970. These reactors are already providing large-scale commercial and industrial experience in the operation of nuclear power stations, while at the same time producing a stockpile of plutonium and generating base-load power with a fuel cost less than half that of the best coal-fired stations. The second generation—upwards of 8,000 MW(e) of Advanced Gas-cooled Reactors, burning enriched uranium—will be completed between 1970 and 1975. These are expected to reduce generating costs significantly below those from any alternative types of power plants, while reducing the demands for capital, advancing established safety standards, and incorporating much of the established technology. The third generation will be sodium-cooled Fast Breeder Reactors. A 250 MW(e) power station of this type is already being constructed at Dounreay. Larger nuclear power stations will be constructed in the years ahead, using initially

the plutonium from the gas-cooled reactors, while producing their own replacement fuel. These should further close the gap in capital costs between nuclear and fossil-fired power stations, while substantially further reducing the fuel and generating costs. They should enable the U.K. to avoid the impact of an increasing price for uranium ore, due to rising world demand, and minimize the uranium import bill. Together by 1985 these three generations of nuclear power stations will give a total of about 50,000 MW(e) and generate at least half of the electricity requirements, to give the U.K. some of the cheapest electricity resources in the world. (auth)

42232 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,370,925. Filed Sept. 4, 1963.

A fuel assembly for a water-cooled and -moderated nuclear reactor is described. The assembly consists of at least three rod-shaped fuel elements and a rod containing burnable poison. All the elements are arranged on parallel axes equispaced around a circle with equal spacing from the poisonrod, which is co-extensive with the elements. The poison rod consists of a zircalloy-filled tube with pellets of a poison such as zirconium diboride or boron carbide, possibly enriched with ^{10}B, dispersed in a matrix of Zr. (IIB)

42233 FUEL-ROD ASSEMBLY FOR NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs GmbH). French Patent 1,346,663. Filed Feb. 5, 1963.

A fuel-rod assembly for a water-moderated and -cooled nuclear reactor is described. The assembly consists of multiple fuel rods arranged in an annular chamber bounded by two co-axial tubes and held in bores in a continuous helical baffle plate which extends transversely of the annular chamber to form a helical channel for the coolant. The space within the inner tube includes two co-axial channels of which the outer is closed at the top and open at the bottom while the inner is open at the top and is connected at the bottom to a coolant supply pipe. Annular insulating gaps are provided externally of the outer of the two co-axial tubes and internally of the inner tube. (IIB)

42234 GAS-COOLED NUCLEAR REACTOR. (to EURATOM). French Patent 1,308,143. Filed Dec. 9, 1961.

A nuclear reactor is described in which the volatile fission products are carried away from the core by the gaseous coolant. Means for purifying and analysing the coolant are provided. Preferably the solid particles contained in the coolant are precipitated by means of a cyclone. Various constructions are given. (IIB)

42235 FUEL CLUSTER FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,408,920. Filed July 10, 1964.

A fuel cluster assembly for a heterogeneous nuclear reactor is described which comprises multiple parallel fuel elements. The fuel elements consist of a cylindrical fuel rod enclosed in a can which is provided with longitudinal radially directed straight fins integral with the can. The fins are arranged to form pairs, each consisting of two fins, one on each of two, adjacent elements and located in the same vertical plane. Removable connecting key members axially slidable in co-operating keyways are provided on the radially outer portions of the fins. (IIB)

42236 IMPLICATIONS OF LARGE ATOMIC POWER STATIONS AS SOURCES OF LOW COST ENERGY IN INDIA. Sarabhai, Vikram A. Nucl. India, 6: 3; 8(Nov. 1967).

The current level of power production in India and the outlook for power cost reduction by constructing large stations with single generating units of 500 to 1000 MW(e) are examined. Implications to the national economy of establishing agro-industrial complexes around large nuclear power stations are discussed. (H.D.R.)

42237 THE NUCLEAR POWER PLANT BEZNAU-DOTTINGEN OF THE NOK. Aemmer, F. Elektrizitaetsverwertung, 42: 69-79(1967). (In German).

A description of the Beznau Power Reactor is given. Detailed descriptions are given of: the reactor core, control rods, primary system, principal reactor pumps, reactivity control, auxiliary systems, and pressure vessel. The secondary, steam conversion, system is discussed. (M.L.S.)

42238 MINIMIZING THE NATURAL FUEL REQUIREMENT FOR NUCLEAR REACTOR POWER SYSTEMS: A NONSTANDARD OPTIMAL CONTROL PROBLEM. Nelson, P. Jr.; Young, G. (Oak Ridge National Lab., Tenn.). J. Optimization Theory Appl., 2: 138-54(Mar. 1968).

A class of model problems in nuclear reactor economics is defined and shown to be equivalent to a linear optimal control problem to which present versions of the maximum principle apparently cannot be applied. It is shown that the search for an optimal control can be restricted to controls of maximum fuel utilization (COMFU), and that the COMFU's are in a one-to-one correspondence with the functions which satisfy certain inequalities and are solutions of a nonlinear Volterra integral equation containing the value of the cost functional as a parameter. In the general case, one can establish an iterative procedure, involving solution of the integral equation at each iteration, for approximating the optimal COMFU. For some important special cases, a point on the solution corresponding to the optimal COMFU is known a priori, and thus the optimal COMFU can be obtained by solving the integral equation only once. Some possible generalizations of the original economic model are also discussed. (auth)

42239 EARLY OPERATIONS AT DOUGLAS POINT. Nucl. Eng., 13: 513-15(June 1968).

The troubles experienced at Douglas Point included the penetration of a calandria tube caused by failure of a booster-rod joint-locking tab, and bearing failure in the primary coolant pumps. The diagnosis and repair of the damage is described, and subsequent operation is outlined. (UK)

42240 NUCLEAR REACTOR FUEL ELEMENT. (to United Kingdom Atomic Energy Authority). French Patent 1,265,090. Filed Aug. 16, 1960.

A fast reactor fuel element is described, comprising a cylindrical sheath with an outer diameter in the range 0.1–0.4 inches, which sheath is of metal of high creep strength with a wall thickness of at least one tenth of the outer diameter so as to be capable of withstanding an internal pressure of at least 10,000 p.s.i. at 600°C, and nuclear fuel enclosed within the sheath and having a cross-sectional shape to provide intimate contact of the fuel with the sheath over at least a major portion of the pheriphery of such shape, there being left unoccupied by the fuel between 10 and 30% of the interior space of the sheath to serve as expansion space for the fuel and also space for accomodation of fission products on irradiation of the fuel. Preferably the fuel is in the form of stacked pellets which are supported or shaped such that spaces between them constitute the unoccupied volume. Various constructions are given. (IIB)

42241 NUCLEAR REACTOR. (to Sulzer Freres). French Patent 1,203,515. Filed Jan. 1958.

A nuclear reactor comprising bodies of metallic fissile material in which are embedded cooling tubes, consisting of Zr or stainless steel is described. Preferably the fissile material is cast or sintered onto the tubes. In order to prevent distortion of the body of fissile material, especially when it consists of U, the material is alloyed with 1.5% of Si and 5% of Zr, or with 1.5% of Si and 1.5% of Fe. However, if the fissile material is alloyed with 7% of Zr and 3% of Nb, its metallic bond with the cooling tubes is improved. (IIB)

42242 BOILING COOLANT NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,274,884. Filed Dec. 2, 1960.

A natural circulation boiling coolant nuclear reactor comprising a pressure vessel containing an active portion which is composed of a plurality of parallel vertical fuel assemblies having coolant channels vertically extending therethrough, and a coolant surrounding said active portion and filling said channels is described. The reactor is provided with a chimney which extends above the active portion to a height just below the level of the coolant and is in communication with the coolant channels, and which has a flow area not less than that of all the coolant channels combined. In a modification the chimney encloses a second chimney, forming with it an annular space which communicates with the coolant channels of the outer assemblies and has a smaller flow area than said channels, the space within the inner chimney being in communication with the coolant channels of the inner assemblies. (IIB)

42243 NUCLEAR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,413,971. Filed Mar. 3, 1966. Addition 89,725.

A fuel assembly for a liquid metal-cooled nuclear reactor is described. The assembly consists of multiple sheathed fuel bars vertically disposed in parallel relation in a casing with upward coolant flow, a narrowed tubular extension in the casing for introducing the coolant into the assembly, and an external shoulder of the extension resting upon an internal shoulder of the channel. In order to prevent possible lifting of the assembly by the coolant flow a latching member is provided. The latch consists of a skirt which surrounds the extension, and multiple longitudinal elastic blades which engage with a horizontal groove in the inner surface of the channel. (IIB)

42244 FUEL ASSEMBLY FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,459,318. Filed Oct. 8, 1965.

A fuel assembly for liquid metal-cooled fast neutron reactors is described. The assembly consists of a vertical tubular sleeve enclosing a cluster of pins of canned fissile material located directly above a second cluster of pin connected fuel pins of fertile material. The clusters slide out of the sleeve through a bottom opening. The assembly is suspended at the top portion and the liquid-metal coolant is circulated downward through the assembly. In a modification the bottom of the assembly is provided with a collecting structure having cavities which are separated by neutron-absorbing walls and which are intended to collect the pins of the bottom cluster in the event of melt-out. (IIB)

42245 HETEROGENEOUS NUCLEAR REACTOR. (to Leonard Seltorp). French Patent 1,389,066. Filed Feb. 5, 1964.

A nuclear reactor is described with a reactor tank containing fuel elements in the form of separate bodies of such dimensions that the reactor is heterogeneous to the neutrons, and a coolant in which the fuel elements float. The elements comprise hollow spherical cases containing fuel in the liquid state and each consists of a fuel-container spaced from a surrounding outer casing provided with openings to permit the coolant to flow from outside the fuel container into the space. The coolant circulation within the reactor tank and a circuit outside the tank is arranged in such a way as to effect rearrangement of the fuel by conveying the fuel elements from the periphery of the tank to its central part and vice versa, whereby fuel elements may also be removed from and charged into the tank by means of the coolant. (IIB)

42246 FUEL ELEMENT FOR A LIQUID-METAL-COOLED NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,428,305. Filed Mar. 5, 1965.

A fuel element for a liquid-metal-cooled nuclear reactor which can be operated at temperatures considerably in excess of 400°C is described. The element comprises a stack of thin wafers of a material fissionable by neutrons of thermal energy and having a thickness no greater than 2 miles, a metal jacket having a hole in the top for fission gas release, and a liquid metal thermal bonding agent. (IIB)

42247 NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,472,105. Filed Dec. 8, 1965.

A nuclear reactor is described, wherein the fuel elements are porous and a liquid coolant is supplied to one side of the element and removed as a vapour at the other side, the phase change occurring while the coolant diffuses through the element. Preferably the porosity of the element increases in the direction of coolant flow through the element. Various constructions are given. (IIB)

42248 LIGHT WATER COOLANT AND MODERATED NUCLEAR REACTOR. (Licentia Patent-Verwaltungs GmbH). French Patent 1,279,117. Filed Feb. 9, 1961.

A water-cooled and -moderated nuclear reactor for the production of superheated steam is described. The core of the reactor is arranged so that the coolant is preheated, vaporized and superheated in a simple passage in one direction through the core channels. The pressure vessel of the reactor is provided with a support plate from which the reactor core is suspended. The core is composed of multiple fuel bars surrounded by narrow channels for coolant flow. The superheated steam emerging from the top of the channels is collected in a steam dome which is secured to the upper side of the support plate. The pressure vessel is filled with water to above the dome forming a surface above which is a cushion of pressure gas. (IIB)

42249 NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-GmbH). French Patent 1,208,092. Filed Dec. 5, 1958.

A nuclear reactor is described having a reactor core which comprises a plurality of fuel elements and wherein due to the core structure, the ratio between the volume of moderator and the associated volume of fuel varies and forms maxima in certain zones of the core. The elements have in their sections which are situated within the said zones a lesser concentration of fissile material than in their other sections and four have added in the said sections a weak neutron absorber. In order to avoid an undesirable increase of the neutron flux when the control rods of the reactor are moved wholly or partly out of the core the rods are provided with extensions which consist of a weak neutron absorber. (IIB)

42250 NUCLEAR REACTOR. (to Babcock and Wilcox Ltd.). French Patent 1,375,517. Filed Nov. 26, 1963.

A liquid cooled reactor is described having the fuel in the core arranged within a plurality of upright hollow fuel element boxes which are positioned in the pressure vessel by a lower support and a removable upper support and which provide paths for the coolant flow. The walls of the boxes extend above the core and the upper support is spaced from the core to such an extent that the surface dose rate of its radioactivity is less than one roentgen per hour when it is removed from the pressure vessel after the reactor is shut down. (IIB)

42251 CORE FOR A THERMAL NUCLEAR REACTOR. (to General Nuclear Engineering Co.). French Patent 1,276,233. Filed Dec. 14, 1960.

A core for a nuclear reactor wherein neutrons are slowed to thermal energy by a neutron moderator, the reactor comprising control rods, and elongate parallel fuel rods, a coolant being passed over the rods, is described. The core comprises a plurality of elongate fuel assemblies laterally spaced from each other for reception of said control rods in the space provided, the portion of the space not occupied by the rods being filled with said neutron moderator. Each assembly comprises at least one region annularly surrounding the assembly's longitudinal axis and containing fuel rods disposed parallel to this axis, each of such regions encompassing an area free of fuel rods and filled with a neutron moderator, said area and moderator being in such relation to the space between assemblies which contains coolant that the fuel elements in a particular assembly operate in substantially the same thermal neutron flux. Various constructions are given. (IIB)

42252 NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,238,755. Filed Nov. 17, 1958.

A fast neutron liquid-cooled nuclear reactor is described comprising a vessel, a core section centrally located within the vessel, a blanket section radially surrounding the core section, and an upper and lower grid plate disposed laterally across the vessel in its bottom portion. The plates are provided with multiple equi-spaced apertures, each of the apertures in the upper plate having a conical seat at its upper end. Both the core section and the blanket section comprise multiple vertically extending hexagonal fuel subassemblies each having a lower extension which is adapted to engage apertures in the upper and lower grid plates. Each vertical face of the subassemblies in the core section is provided with a protuberance disposed in its mid-portion and adapted to engage a protuberance on an adjacent subassembly to restrict lateral bending of the subassemblies during operation. (IIB)

42253 NUCLEAR FUEL ASSEMBLY. (to EURATOM) French Patent 1,352,023. Filed Mar. 27, 1963.

A fuel assembly is described for a heavy water-moderated nuclear reactor which is cooled by a fluid circulating under pressure in channels formed by pressure tubes containing the fuel assemblies. The assembly comprises an external jacket, a cluster of fuel rods held within the jacket by cross members secured to the jacket, a thermal insulating sheath occupying the space between the jacket and the pressure tube, means on the jacket for retaining the sheath against axial movement, and seating means at one or each end of the assembly for the end of an adjacent assembly whereby several assemblies may be stacked in a column. Various constructions are given. (IIB)

42254 NUCLEAR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,413,971. Filed Aug. 28, 1964.

A fuel assembly for a liquid metal-cooled nuclear reactor is described which comprises multiple sheathed fuel bars vertically disposed in parallel relation in a casing through which an ascendant flow of coolant is fed. The fuel elements are supported at each end and are free to move in axial directions when raised to the operating temperature. The lower end of the casing is provided with a narrowed tubular extension for introducing the coolant into the assembly which is disposed in a vertical channel of a support. In order to prevent possible lifting of the assembly by the coolant flow a latching member is provided comprising a skirt which surrounds the extension and consists of a plurality of longitudinal elastic blades. (IIB)

42255 NUCLEAR REACTOR FUEL ASSEMBLY. (to United States Atomic Energy Commission). French Patent 1,345,931. Filed Jan. 21, 1963.

A fuel assembly for producing superheated steam within a reactor vessel is described. The assembly comprises an outer containment tube for circulation of a primary coolant, a first tube which is rigidly supported within the outer tube and has a closed lower end and an open upper end for the introduction of saturated steam or the removal of superheated steam, a second tube concentric with the first which is open at both ends and extending into the first tube, and a quantity of fissile fuel supported within the annulus between the first and second concentric tubes. The outer containment tube concentrically surrounds the first inner tube and

is composed of a material having a low thermal neutron absorption, and a second quantity of fissile fuel is supported within the annulus between the first inner tube and the containment tube. A heat insulating liner may be interposed between the annular spaces. (IIB)

42256 THE EXPECTABLE ROLE OF THE NUCLEAR POWER IN THE ENERGY SUPPLY. Koekeny, Mihaly. Energ. Atomtech., 20: 410-14(Sept. 1967). (In Hungarian).

The development of energy demand and of the structure of primary energy consumption is described. The mighty press foreward in the field of building nuclear power plants is described, the causes of this are analysed and an estimate of the expectable development of nuclear power engineering in the future is presented. The costs of electricity being generated in nuclear power plants and in the classical heat power plants are analysed by comparison and the investment unit costs are compared. The several types of power reactors are evaluated. The expected development of demand and costs of fissile materials are discussed. The influences of extension of the nuclear power plants on the industrial structure and industrial technologies are described. (auth)

42257 FUEL ELEMENT ASSEMBLY FOR A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,345,156. Filed Oct. 26, 1962.

A fuel element assembly for a gas-cooled nuclear reactor is described. The core consists of multiple elongate adjacent moderator blocks of polygonal cross section (e.g., hexagonal, rectangular or triangular) of which some are omitted from the structure to provide spaces defining channels for the coolant gas with at least one fuel element. Preferably there are provided a plurality of fuel elements each comprising fissile material housed in can means. Each channel comprises a like number of symmetrically arranged intercommunicating lobes. Each of the can means is disposed substantially along the axis of a respective lobe and is supported by supporting members consisting of metal or a moderating material which are also adapted to guide and deflect the coolant during operation. Various constructions are given. (NPO)

42258 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Aktiebolaget Atomenergi). French Patent 1,456,605. Filed July 20, 1965.

An elongate fuel element which comprises a number of sheathed fuel rods or tubes surrounded by a tube through which a boiling coolant flows is described. In order to improve the heat exchange conditions the surrounding tube contains itself a fissile material and its outer surface is cladded with a heat insulating layer, which is preferably composed of an oxide (e.g., ZrO_2, MgO, Al_2O_3). (NPO)

42259 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-GmbH.). French Patent 1,469,386. Filed Feb. 17, 1966.

A cylindrical or tubular fuel element is described which is intended to be steam-cooled during operation and which comprises a ceramic fuel sheathed with a metallic can. The can consists of a metal or an alloy having a low neutron absorption and a high mechanical resistance and its surface which is intended to face the steam is coated with a metal or an alloy having a high corrosion resistance to the operating temperature (e.g., Zircaloy or Incoloy). (NPO)

42260 NUCLEAR FUEL ASSEMBLY. (to United States Atomic Energy Commission). French Patent 1,284,925. Filed Mar. 24, 1961.

A fuel assembly is described comprising a vertical tubular container which is closed at its bottom end, a reactive core which forms a lower plenum with the bottom and a reflector located above the core, a corrugated tube which encloses and supports the reflector and the core spaced from the wall of the container, a closure at the top of the assembly for suspending the corrugated tube, and an upper plenum formed directly beneath the closure. Below the upper plenum the container is provided with an inlet for passing a solid-gas suspension coolant around the reflector and the core into the lower plenum. The reflector and the core are provided with passageways for carrying the coolant from the lower into the upper plenum. The passageways are provided with turbulence promotors to increase the heat transfer from the core to the coolant. (IIB)

42261 CRITICAL CHEMICAL PROBLEMS IN THE DEVELOPMENT OF NUCLEAR REACTORS. Swartout, John A. (Union Carbide Corp., New York). J. Chem. Educ., 45: 304-10(May 1968).

Various power reactor types and problems in their development are reviewed. Chemical problems that affect the operation, economy, and safety of burner or low-conversion reactors, advanced converters, and breeders are considered. (M.C.G.)

42262 THE GUARANTEE AND INSPECTION SYSTEM OF THE IAEA. Polomskii, F. Kernenergie, 11: 121-5(May 1968). (In German).

A review of the principles of the IAEA guarantee system (1965) for the control of nuclear plants and the methods of practical control included in the document of inspectors is given. The recent state of employing the guarantees is discussed in connection with their meaning with respect to the treaty on non-proliferation of nuclear weapons. (auth)

42263 FUEL ELEMENT FOR NUCLEAR REACTORS. (to Gesellschaft fuer Kernforschung mbH). French Patent 1,406,721. Filed July 3, 1964.

A fuel element, particularly for fast reactors, is described having longitudinal cooling fins directed towards adjacent elements. The fins also serve as spacers. In order to prevent longitudinal vibration of the element even at high cooling gas velocities the fins are formed partly as hooks which are open in the axial direction of the element and are adapted to engage in correspondingly shaped hooks on the fins of adjacent element. In addition this construction has the advantage of allowing some axial movement relatively to the adjacent elements to equalize thermal stresses. (NPO)

42264 ANNULAR FUEL ELEMENT FOR A NUCLEAR REACTOR. Fuhrmann, Robert; Michel, Marcel (to Commissariat a l'Energie Atomique). British Patent 1,121,979. July 31, 1968. Priority date May 27, 1966, France.

An annular fuel element for a CO_2-cooled graphite-moderated reactor is described. The external surface of a tubular natural U slug is clad with a Mg-base alloy and the internal surface is clad with Zr or a Zr-base alloy having a higher hot strength than the Mg alloy. The internal cladding is also provided with shallow chevron fins to improve heat transfer. (H.D.R.)

42265 IMPROVEMENTS IN OR RELATING TO A METHOD OF REGULATING STEAM PRESSURE AND A THERMAL EXCESS-PRESSURE DEVICE OR "PRESSURIZER" EMPLOYING SAID METHOD. (to Commissariat a l'Energie Atomique). British Patent 1,121,984. July 31, 1968. Priority date Sept. 30, 1965. France.

A pressurizer associated with the primary circuit of a water-cooled reactor is provided with a heat exchanger in the steam phase of the pressurizer container. Part of the expansion water from the primary circuit is directed through this heat exchanger to prevent an excessive increase in steam pressure when reactor power demand is reduced. (H.D.R.)

42266 IMPROVEMENTS IN OR RELATING TO ELECTRICAL CONTROL OR MONITORING EQUIPMENT OR APPARATUS. Allen, Philip (to E. K. Cole Ltd.). British Patent 1,118,281. June 26, 1968. Filed Nov. 16, 1964.

A means for monitoring the equipment in the control and interlock circuits of reactors is described. The monitoring means is of the type which comprises a module adapted to simultaneously receive a number of individual control signals and a checking signal. The module is arranged to operate as a logic circuit with each control signal controlling the operation of at least two switching transistors. Each switching transistor has the checking signal applied to it so that pulses passing through the switching arrangement and corresponding with the checking pulses are developed at the output of a module only when at least a predetermined number of control pulse trains are present. (H.D.R.)

42267 STUDIES ON THE LOSS-OF-COOLANT ACCIDENT IN WATER-COOLED NUCLEAR POWER REACTORS. Takekoshi, Tadasu; Nakata, Seibei (Electrotech Lab., Tokyo). Denki Shikensho Iho, 31: 1233-46(Dec. 1967). (In Japanese).

A blowdown test facility was constructed in 1965 to develop information on the blowdown phenomena associated with a loss-of-coolant accident in water-cooled power reactors. The research program consists of blowdown tests and theoretical studies about the blowdown phenomena during the loss-of-coolant accident. The entire primary coolant system includes both BWR loop and PWR loop. Provisions simulating a pipe rupture are located close to the coolant inlet and outlet of the reactor vessel in PWR loop, while close to the steam outlet at the top of steam separator and the coolant inlet at the bottom of reactor vessel in BWR loop. Instrumentation is included to permit measurement of the transient response of the coolant on the pressure, temperature and density. Parametric tests have been conducted to determine the influence of rupture size, rupture location, initial coolant temperature and system pressure on the rate of change of void fraction and on the mass of water remaining in the system following the accident. The major results obtained are as follows: top blowdown tests show that the degree of phase separation and amount of water remaining in the vessel seem to be closely coupled with each other; and theo-

retical studies show that some empirical flow coefficients must be considered in applying existing critical flow models to predict the coolant discharge rate from the test facility. (auth) (NSA of Japan)

42268 METHOD AND APPARATUS FOR CONTROLLING THE POWER OF A NUCLEAR REACTOR. Gilbert, Jacques (to Sulzer Brothers Ltd.). U. S. Patent 3,391,058. July 2, 1968. Priority date Sept. 10, 1964, Switzerland.

The control rods positioned intermediately within the reactor core control the power of the reactor. Upon movement of these intermediate rods into one of their end ranges, a corresponding number of rods either fully in or fully out of the reactor core move out or into the core. The intermediate control rods also control reactor output during movements of other rods of a closed loop into or out of the core. (Offic. Gaz.)

42269 NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,415,089. Filed Nov. 10, 1964.

A thermal nuclear reactor is described comprising blanket elements of fertile material heterogeneously arranged throughout the reactor. The fertile material contains a lower amount of fissionable isotope than does natural uranium, and a plurality of seed assemblies contain a material fissionable by thermal neutrons uniformly distributed in the blanket elements. Each of the seed assemblies is subcritical when not within the blanket elements and is individually critical when placed within the elements. Preferably the material fissionable by thermal neutrons is UO_2 enriched with U-235 and the fertile material is ThO_2. There is at least one seed assembly per each 5 megawatt electrical design capacity of the reactor. (NPO)

42270 STEAM PRODUCERS FOR NUCLEAR POWER PLANTS WITH PRESSURIZED WATER REACTORS. Fratzscher, Wolfgang (Technische Univ., Dresden). Wiss. Z. Tech. Univ. Dresden, 16: 21-9(1967). (In German).

The technically most important steam generators for nuclear power plants with pressurized water reactors may be classified according to the position and number of drums. A few types of construction of prototypes and test power plants include intermediate positions; the steam generator of the Rheinsberg plant can be described as single vertical and as multiple drum aggregates. Four types of generators are defined and compared technically and economically. Vertical types, particularly the single drum generators, have good results because of their compact construction and convenient arrangement of heating units; values for power, volume and surface requirements, specific heat surface value, and economic values are favorable for this type. Maximum power for this type is 450 MW. A higher value would be possible by increase of the mean temperature difference, but this is offset by economic considerations. (BBB)

42271 NUCLEAR ENERGY IN THE WORLD: A CRITICAL ANALYSIS IN THE YEAR 1967. Held, Christian. Elektrotech. Maschinenbau., 85: 147-53(Apr. 1968). (In German).

The 60 nuclear power stations in the world now produce 10 GW, 1% of the world's total power production. By 1980, nuclear power stations will produce 300 GW, 20% of the total. Development of a variety of types of reactors is tied to military exploitation of the atom. These types' histories are traced; development of natural U reactors and later types in the United States is emphasized. The following extrapolations for the West German economy are made: fossil fuel plants, nuclear plants with burners and nuclear plants with breeders will each hold about a third of production, but 1978 is too early a date for usable breeders. Burners will be able to consume Pu from the breeder excess. Current production costs for the power nets will quickly be reduced to 30%. Use of natural U will reach an equilibrium value in spite of nuclear power increases because of the use of breeders. Projections of these and other data until 2010 are graphed: In the year 2010, 80×10^3 tons of natural U will be used; the cost of current production will be 2.3 Dpfg/kWh. (BBB)

42272 FAST BREEDERS. Mialki, Werner (Univ., Berlin). Bild Wiss., 5: 199-207(Mar. 1968). (In German).

The history and principles of fast breeders are reviewed. Attention is devoted to the production of ^{239}Pu from ^{238}U for use in breeders. Efficiency requirements are noted, and the design of units to encompass these requirements are outlined. An example of the earliest type, natural U-graphite, serves to illustrate efficiency problems. Construction of a fast breeder is contrasted with that of the original U-graphite reactor. The differences are primarily the higher concentration of fissionable material in the fission zone and the absence of moderators. Discussion of coolants indicates why water is not used in such units. (BBB)

42273 IMPROVEMENT IN A FUEL ELEMENT ASSEMBLY FOR GAS-COOLED NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,387,264. Filed Dec. 12, 1963.

A fuel assembly is described in which canned fuel rods are assembled in parallel relation so as to form a fuel cluster. The rods are maintained in this geometry by means of at least one support grid having an outer sleeve. The improvement comprises fitting the outer sleeve with a heat insulating packing keyed in position to the sleeve by means of a vibration-absorbing material, e.g. graphite felt. The packing may consist of silica, expanded alumina, silicon carbide foam or silica fibre clad with a thin metallic sheet. (NPO)

42274 NUCLEAR REACTOR. (to Aktiebolaget Atomenergi). French Patent 1,251,708. Filed Mar. 18, 1960.

A heterogeneous nuclear reactor is described which is heavy water moderated and cooled. The assemblies have a length that is not more than one-tenth of the core length of the reactor and are situated in predetermined spaced relationship. The fuel assemblies are separated by moderator spaces so that the water, having left one assembly, must pass through a moderator space before it enters the next assembly. Various constructions are given. (NPO)

42275 HOLLOW CYLINDRICAL FUEL ELEMENT FOR NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-GmbH). French Patent 1,473,412. Filed Mar. 5, 1966.

A fuel element comprising a tube of fissile material which is provided with an inner and an outer sheath is described. In operation the saturated vapour of the boiling coolant, which is generated at the outer sheath, is passed through the central channel for the purpose of super heating. In order to increase the heat-supply to the vapour and to decrease the heat-supply to the coolant a layer of a material having a low heat conductivity (e.g., He or a porous ceramic) is interposed between the fuel and the outer sheath. In a modification the outer layer of the fuel (UO_2) is converted into a hyperstoichiometric form (e.g., $UO_{2.3}$) Preferably the tube is divided into two coaxial cylinders, the inner cylinder having an increased heat conductivity by mixing the fissile material with BeO or with metal fibres (e.g., of Mo). In a modification the inner cylinder is composed of a fissile material which is more enriched than that of the outer cylinder, resulting in an increased heat development in the inner cylinder. (NPO)

42276 TESTING FOR FUEL ELEMENT SHEATHING FAILURES IN NUCLEAR REACTORS. Jackson, George Oliver (to United Kingdom Atomic Energy Authority). U. S. Patent 3,393,125. July 16, 1968. Priority date Nov. 12, 1964, Great Britain.

For testing for the occurrence of fuel element sheathing failures in nuclear reactors of the kind including a core having fuel elements disposed in coolant channels with the core contained in a vessel, suitable apparatus comprises a sample chamber within the vessel and shielded from core radiation, means for conveying coolant samples from a fuel element channel outlet through the sample chamber via a sample pipe, a detector disposed outside the vessel and able to detect neutrons resulting from a sheathing failure and emitted from a coolant sample in the chamber, and means for confining the emitted radiation to the locality of the detector with attenuation of radiation other than neutrons. (Offic. Gaz.)

42277 THERMOSIPHON DEEP POOL REACTOR. Detman, Roger F.; Whipp, James V. Jr. (to C. F. Braun and Co.). U. S. Patent 3,393,127. July 16, 1968. Filed Jan. 6, 1966.

A thermosiphon is described comprising within a bore hole a nuclear reactor having a liquid inlet side and a liquid outlet side, three separate concentric annular chambers above the reactor, and control means for operating the reactor traversing the innermost chamber. The innermost chamber and reactor are separated by an essentially water-tight barrier. The outermost annular chamber comprises a conduit for conducting liquid from the upper end to the inlet side of the reactor. The intermediate chamber between the innermost and outermost chambers comprises at least one annular conduit for conducting liquid from above the reactor to the upper end of said intermediate chamber. Also described is a system for the generation of steam in a closed loop comprising continuously heating water under hydrostatic pressure in a bore hole in proximity to a nuclear reactor, gradually reducing the hydrostatic pressure on the water to permit at least partial vaporization and continuously condensing the vapor and permitting the condensate together with the unvaporized water to be recycled by thermosiphoning action to the heating zone. (Offic. Gaz.)

42278 SHAFT-SEALING DEVICE FOR TURBOMACHINES HAVING A GASEOUS WORKING MEDIUM HEATED IN A NUCLEAR REACTOR. Spillmann, Werner (to Escher Wyss Aktiengesells-

chaft). U. S. Patent 3,390, 525. July 2, 1968. Priority date Jan. 14, 1965, Switzerland.

A turbo-compressor nuclear power plant of the closed circuit type includes a pressure tight housing through which a rotary shaft extends. Leakage between the shaft and housing is prevented by a shaft bearing mounted in pressure tight relation to the housing. A labyrinth gland is also mounted in pressure tight relation to the housing and is located between the bearing and the rotary turbine and compressor. The gland is divided into two parts by an encircling chamber. There is a second chamber between the bearing and the gland. An extraction conduit extends from the compressor through an isotope trap to the first chamber. A return conduit, provided with a lubricant trap, extends from the second chamber to the closed circuit at a point where the pressure is lower than that in the second chamber. (Offic. Gaz.)

42279 NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,417,483. Filed Nov. 30, 1964.

A nuclear reactor is described comprising a moderator mass, e.g., heavy water, traversed by a number of vertical pressure tubes each of which contains an assembly of parallel elongate fuel elements and is provided with a bottom inlet for a primary flow of coolant, e.g., light water, which is vaporized during operation. The steam is carried away from the top of the assembly. In order to protect the fuel elements from damage in case of a break-down in the coolant circuit a device is provided for introducing a secondary flow of coolant into the assembly. The device comprises a vertical tube which is axially disposed in the assembly one end being closed, the other being connected to a coolant tank, and its wall being provided with perforations. The connection between the tube and the tank is provided with a remote controlled normally closed valve which is opened by an energency signal, thus allowing a secondary flow of coolant to be fed in lateral direction into the assembly through the perforations in the wall of the central tube. (NPO)

42280 DOMESTIC PRODUCTION OF NUCLEAR POWER GENERATION EQUIPMENT. Hisadome, Yoshio (Ministry of International Trade and Industry, Japan); Arai, T. Genshiryoku Kogyo, 14: 4-33(June 1968). (In Japanese).

Domestic production of nuclear power generation equipment in Japan is described; the problems encountered are discussed. The following articles analyze the production capabilities and associated problems: "Some Problems in the Domestic Production of Nuclear Power Generation Equipment," by Y. Hisadome; "Boiling-Water Reactor," by T. Arai; "Boiling-Water Reactor," by T. Masuda; "Pressurized-Water Reactor," by T. Tsuda et al.; and "Advanced Gas-Cooled Reactor," by R. Anahara. (NSA of Japan)

42281 NUCLEAR FUEL ELEMENT CONTAINER. (to United Kingdom Atomic Energy Authority). French Patent 1,466,018. Filed Jan. 20, 1966.

A container for a fuel element is described which is intended to be used in a gas-cooled reactor with CO_2 coolant. The container consists of an Fe-based alloy or a Ni-based Fe-containing alloy and is provided with an outer coating of an oxidation resistant material (e.g., Al, Cr, Ni, Si, mixed oxides or glass) having a thickness of 10 to 40 μ. Preferably a diffusion barrier (e.g., a layer of porous Al_2O_3) is provided between the container and the coating. (NPO)

42282 DETERMINATION OF THE TECHNICAL-ECONOMIC INDICATORS OF COMBINED NUCLEAR POWER STATIONS, EQUIPPED WITH PRESSURE-WATER REACTORS. Haiduc, C. Stud. Cercet. Energ. Electroteh., 17: 473-85(1967). (In Rumanian).

The analytical expressions for the calculation of the technical-economic indicators of combined nuclear power stations as compared with superheating nuclear power stations are presented. The technical-economic analysis favors the higher efficiency of the nuclear stage in combined nuclear power stations. (auth)(Rom. Sci. Abstr.)

42283 HIGH POWER IRRADIATION TEST OF TA NO. 2R IN JPDR MONKEY PROJECT. PART I. Wakasugi, Kazuhiko (Toshiba Central Research Lab., Kanagawa, Japan); Shimooke, Takanori; Morishima, Atsuyoshi. J. Nucl. Sci. Technol. (Tokyo), 5: 365-73(July 1968).

Irradiation tests on a fuel rod in locally enhanced heat flux were undertaken in the Japan Power Demonstration Reactor, with the use of a modified form of the experimental fuel assembly TA#2R. Design calculations for this test fuel assembly, out-pile experiments and analysis of various safety problems related to in-core irradiation of the assembly are described. It is shown that it is possible to irradiate the fuel rod in heat flux as high as 500,000 Btu/hr · ft^2. 16 references. (auth)

42284 A STUDY OF CORE OPTIMIZATION FROM THE VIEW POINT OF NEUTRON FLUX DISTRIBUTION. Hara, Fumio; Shibata, Heki (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 323-32(July 1968).

The optimization of a nuclear converter core in respect of thermal power, power peaking and fuel conversion ratio is studied from the aspect of neutron flux distribution. It is shown that flattening the neutron flux distribution maximizes the thermal power output. A mathematical approach to the problem of flattening the neutron flux distribution is presented for a regionized reactor. Minimization of power peaking at the border of the region of flattened flux is considered with one- and two-group approximations. The analyses on one dimensional model has led to the result that the optimal reactor should be three-regional. (auth)

42285 SCATTERING PROCESS APPROACH TO NEUTRON SPECTRUM IN FAST REACTOR. Inoue, Kazuhiko (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 333-41(July 1968).

The neutron spectrum in a fast reactor is formulated from a new approach for an infinite homogeneous medium and is given in a form that allows explicit evaluation of each scattering collision process. Mathematically, the procedure is equivalent to that based on the balance equation. Numerical evaluation indicates that there exists only small probability of a neutron undergoing inelastic scattering more than several times. Applying the formulas thus derived, an approximate representation of the spectrum has been obtained in a simple form, and which includes the multiple inelastic scattering effects. (auth)

42286 SPACE DEPENDENT REACTOR KINETICS WITH POSITIVE FEEDBACK. Kastenberg, William E. (Univ. of California, Los Angeles). Nukleonik, 11: 126-30(1968).

Stability criteria for spatially dependent, nonlinear kinetics with positive and varying feedback is presented. When the reactor has strictly positive feedback a domain of stability as well as instability is shown to exist. The stability criteria depends on the relationship between $\varkappa_0^2$, the generalized buckling and μ_0^2, the smallest eigenvalue of the associated Helmholtz equation as well as the feedback coefficient, the feedback kernel and the bound on the initial flux. For varying feedback, the domain of stability depends on the relationship between the varying feedback coefficient and its relationship to a corresponding positive case. Both problems are treated by the method of comparison functions. (auth)

42287 METHOD AND APPARATUS FOR THE CONTROL OF A NUCLEAR REACTOR. Kagi, Jakob (to Sulzer Brothers Ltd.). Canadian Patent 783,669. Apr. 23, 1968. Priority date Sept. 13, 1963, Switzerland.

A method is described for controlling the output of a nuclear reactor plant by having a gaseous coolant flow over the fuel and then transfer its acquired heat to two separate "evaporable load medium" circuits. A system of sensors and values controls the rate of flow of feed water to the two evaporable load medium circuits in dependence on the temperature of the gaseous coolant entering the fuel channels. An adjustment of the individual rates of feed flow to the two circuits depends on comparison of the live vapor pressure in the two circuits by devices to equalize these two vapor pressures. The secondary heat transfer medium may be liquid, vapor, or superheated vapor and of course supplies the energy to the turbines for power generation. Conventional control rods are also used in conjunction with the sum of the live vapor pressure in the two secondary circuits. (F.S.A.)

42288 NUCLEAR REACTOR WITH A PEBBLE-BED OF FUEL ELEMENTS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,122,991. Aug. 7, 1968. Priority date Sept. 12, 1964, Germany.

A description of a pebble-bed nuclear reactor is presented. The reactor consists of spherical fuel particles, a cylindrical core vessel, and multiple rows of guide surfaces for the circulating fuel particles. The guide surfaces form an angle less than 20° with the cylindrical core vessel and slope toward the fuel extraction duct in the center of the vessel. (D.C.C.)

42289 NUCLEAR REACTOR STRUCTURE. (to Canadian General Electric Co., Ltd.). British Patent 1,122,373. Aug. 7, 1968. Priority date May 29, 1965, Canada.

A description of an improved CANDU-type reactor is presented. The improvement consists of tightly sealed pressurized fuel channels transversing the pressure vessel. The concrete pressure vessel and sealing members for the fuel channels are water-cooled and -shielded. A built-in dump tank is provided in the pressure vessel for the moderator. The pressurized fuel channels contain an annular space filled with insulating gas. (D.C.C.)

42290 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Rennie, Compton Alexander; Lockett, George Ed-

ward; Acciarri, Pietro (to United Kingdom Atomic Energy Authority). British Patent 1,122,272. Aug. 7, 1968. Filed Nov. 24, 1964.

A description of a multi-zone gas-cooled nuclear reactor is presented. The reactor contains multiple vertical and parallel fuel zones. The fuel is spherical and is driven pneumatically by the gas coolant. A rotating conduit regulates the fuel passage from the fuel zones. (D.C.C.)

42291 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Rigg, Shepherd (to United Kingdom Atomic Energy Authority). British Patent 1,122,452. Aug. 7, 1968. Filed Nov. 25, 1965.

A description of an integral nuclear reactor is presented. The reactor consists of a reactor core and heat exchanger enclosed in the reactor vessel. The primary coolant transfers heat to an external secondary coolant by the internal heat exchanger. The secondary coolant enters a sealed annular section in the reactor vessel and allows external heat transfer from the heat exchanger. (D.C.C.)

42292 ULTRASONIC APPARATUS FOR MEASURING THE POSITION OF A LIQUID LEVEL. Buis, Hendrik (to Commissariat a l'Energie Atomique). British Patent 1,123,939. Aug. 14, 1968. Priority date Dec. 15, 1965, France.

A description of an ultrasonic apparatus for measuring a liquid level in a liquid metal-cooled fast reactor is presented. The apparatus consists of a transmitter of ultrasonic waves, a receiver, a tubular waveguide facing the transmitter and filled with NaK, and a kerosene-filled cylindrical tube enclosing the waveguide tube. (D.C.C.)

42293 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Warner, Philip Cloudesley; Bennett, John Charles (to United Power Co., Ltd.). British Patent 1,123,972. Aug. 14, 1968. Filed Sept. 8, 1964.

A description of a gas-cooled graphite-moderated nuclear reactor is presented. The reactor core and heat exchanger are enclosed in a gas-tight reinforced concrete pressure vessel. The reactor core is separated from the heat exchangers by a cylindrical shell. Coolant is circulated upward through the reactor core. (D.C.C.)

Marine and Portable Power Reactors

42294 (DOCKET-50238-5) N.S. SAVANNAH: LICENSE APPLICATION. (First Atomic Ship Transport, Inc., New York). Apr. 30, 1965. 84p. Dep. CFSTI.

The agreement between the American Export Isbrandtsen Lines, Inc. (AEIL) and First Atomic Ship Transport, Inc. (FAST) for the purpose of operating the N.S. Savannah is included. Technical qualifications of AEIL and its personnel are given. Economic data on FAST are tabulated. (M.L.S.)

42295 (DOCKET-50238-25) N.S. SAVANNAH [STATUS OF ON-BOARD FILTER TESTING PROGRAM]. (First Atomic Ship Transport, Inc., New York). Sept. 15, 1967. 2p. Dep. CFSTI.

42296 (DOCKET-50238-35) N.S. SAVANNAH [REPORT ON FAILURE OF VENT PIPING FOR PRIMARY COOLANT PUMP]. (First Atomic Ship Transport, Inc., New York). Nov. 27, 1967. 2p. Dep. CFSTI.

42297 (DOCKET-50238-36) N.S. SAVANNAH: INCIDENT REPORT ON VALVE FAILURE. (First Atomic Ship Transport, Inc., New York). Dec. 4, 1967. 7p. Dep. CFSTI.

42298 (DOCKET-50238-9) N.S. SAVANNAH FINAL SAFEGUARDS REPORT: TEST, STARTUP, AND TRIALS. (New York Shipbuilding Corp., Camden, N. J.). Sept. 16, 1960. 171p. Dep. CFSTI.

The complete procedures for checkout of the power plant and reactor systems of the N. S. Savannah are given. (M.L.S.)

42299 (DOCKET-50238-19) [N.S. SAVANNAH: SAFETY ASSESSMENT. LETTER ON OPERATIONS REVIEW BY DRL]. (First Atomic Ship Transport, Inc., New York). Dec. 8, 1966. 4p. Dep. CFSTI.

42300 (DOCKET-50238-20) N.S. SAVANNAH SAFEGUARDS REPORT. ADDITIONAL DESIGN FEATURES. Supplement to Volume I. (New York Shipbuilding Corp., Camden, N. J.). Sept. 16, 1960. 27p. Dep. CFSTI.

Ventilation systems for the reactor compartment of the N. S. Savannah are described; leakage monitoring is discussed. The continuous leakage monitoring system for the containment system is discussed. (M.L.S.)

42301 (DOCKET-50238-42) MISSILE ANALYSIS: N.S. SAVANNAH CONTAINMENT. Crane, A. T. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Dec. 12, 1967. 11p. (UNC-5197). Dep. CFSTI.

For First Atomic Ship Transport, Inc., New York.

42302 (DOCKET-50238-22) REANALYSIS OF N.S. SAVANNAH LOSS-OF-COOLANT ACCIDENT. Cooper, M. H.; Hankel, R. D. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Aug. 1, 1967. 133p. (UNC-5185). Dep. CFSTI.

For First Atomic Ship Transport, Inc., New York.

42303 (DOCKET-50238-43) REANALYSIS OF N.S. SAVANNAH LOSS-OF-COOLANT ACCIDENT. PHASE II. Crane, A.; Williams, F. J. Jr. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Dec. 7, 1967. 36p. (UNC-5191). Dep. CFSTI.

For First Atomic Ship Transport, Inc., New York.

42304 (DOCKET-50238-6) N.S. SAVANNAH: TECHNICAL SPECIFICATIONS. (First Atomic Ship Transport, Inc., New York). Apr. 1965. 31p. (FAST-1). Dep. CFSTI.

42305 (DOCKET-50238-34) TECHNICAL SPECIFICATIONS, CHANGE NO. 16-2. (First Atomic Ship Transport, Inc., New York). Oct. 26, 1967. 1p. Dep. CFSTI.

42306 (DOCKET-50238-24) TECHNICAL SPECIFICATIONS, CHANGE NO. 16-1. (First Atomic Ship Transport, Inc., New York). Oct. 6, 1967. 3p. Dep. CFSTI.

42307 (DOCKET-50238-38) TECHNICAL SPECIFICATIONS, CHANGE NO. 15-2. (First Atomic Ship Transport, Inc., New York). Dec. 11, 1967. 1p. Dep. CFSTI.

42308 (DOCKET-50238-39) TECHNICAL SPECIFICATIONS, CHANGE NO. 15-1. (First Atomic Ship Transport, Inc., New York). July 24, 1967. 7p. Dep. CFSTI.

42309 (DOCKET-50238-16) TECHNICAL SPECIFICATIONS, CHANGE NO. 12. (First Atomic Ship Transport, Inc., New York). Dec. 28, 1966. 2p. Dep. CFSTI.

42310 (DOCKET-50238-13) TECHNICAL SPECIFICATIONS, CHANGE NO. 11. (First Atomic Ship Transport, Inc., New York). Dec. 12, 1966. 3p. Dep. CFSTI.

42311 (DOCKET-50238-14) TECHNICAL SPECIFICATIONS, CHANGE NO. 10. (First Atomic Ship Transport, Inc., New York). Dec. 8, 1966. 3p. Dep. CFSTI.

42312 (DOCKET-50238-15) TECHNICAL SPECIFICATIONS, CHANGE NO. 9. (First Atomic Ship Transport, Inc., New York). Dec. 9, 1966. 2p. Dep. CFSTI.

42313 (DOCKET-50238-40) TECHNICAL SPECIFICATIONS, CHANGE NO. 8-3. (DFirst Atomic Ship Transport, Inc., New York). Dec. 13, 1967. 10p. Dep. CFSTI.

42314 (DOCKET-50238-37) TECHNICAL SPECIFICATIONS, CHANGE NO. 8-2. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). Nov. 7, 1967. 5p. Dep. CFSTI.

42315 (DOCKET-50238-12) TECHNICAL SPECIFICATIONS, CHANGE NO. 8-1. (First Atomic Ship Transport, Inc., New York). Dec. 5, 1966. 20p. Dep. CFSTI.

42316 (DOCKET-50238-11) TECHNICAL SPECIFICATIONS, CHANGE NO. 7-2. (First Atomic Ship Transport, Inc., New York). Oct. 31, 1966. 6p. Dep. CFSTI.

42317 (DOCKET-50238-29) TECHNICAL SPECIFICATIONS, CHANGE NO. 7-1. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). Aug. 2, 1967. 4p. Dep. CFSTI.

42318 (DOCKET-50238-10) TECHNICAL SPECIFICATIONS, CHANGE NO. 6-2. (First Atomic Ship Transport, Inc., New York). Oct. 24, 1966. 2p. Dep. CFSTI.

42319 (DOCKET-50238-21) [N.S. SAVANNAH: TECHNICAL SPECIFICATIONS], CHANGE NO. 6-1. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). June 26, 1967. 4p. Dep. CFSTI.

42320 (DOCKET-50238-18) [N.S. SAVANNAH: TECHNICAL SPECIFICATIONS], CHANGE NO. 5. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). Feb. 6, 1967. 9p. Dep. CFSTI.

42321 (DOCKET-50238-32) TECHNICAL SPECIFICATIONS, CHANGE NO. 4. Safety Evaluation. (Division of Reactor

Licensing (AEC), Washington, D. C.). Sept. 7, 1966. 3p. Dep. CFSTI.

42322 (DOCKET-50238-33) N.S. SAVANNAH: TECHNICAL SPECIFICATIONS, CHANGE NO. 3. (Division of Reactor Licensing (AEC), Washington, D. C.). Sept. 7, 1966. 4p. Dep. CFSTI.

42323 (DOCKET-50238-7) N.S. SAVANNAH: PORT OPERATION CRITERIA. (First Atomic Ship Transport, Inc., New York). Apr. 1965. 14p. (FAST-2). Dep. CFSTI.

42324 (DOCKET-50238-8) N.S. SAVANNAH [DOMESTIC AND FOREIGN PORT VISITATION]. (Atomic Energy Commission, Washington, D. C.). June 4, 1964. 19p. Dep. CFSTI.

42325 (DOCKET-50238-17) N.S. SAVANNAH: PORT OPERATIONS FOR THESSALONIKI, GREECE. Port Review No. 23. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). Dec. 13, 1966. 5p. Dep. CFSTI.

42326 (DOCKET-50238-23) EAST RIVER TRANSIT. (First Atomic Ship Transport, Inc., New York). Nov. 2, 1967. 9p. (FAST-162). Dep. CFSTI.

42327 (DOCKET-50238-26) PORT OPERATING PLAN FOR NAHA, OKINAWA. (First Atomic Ship Transport, Inc., New York). July 1967. 24p. (FAST-158). Dep. CFSTI.

42328 (DOCKET-50238-27) PORT OPERATING PLAN, BRUNSWICK, GEORGIA. (First Atomic Ship Transport, Inc., New York). Aug. 11, 1967. 1p. Dep. CFSTI.

42329 (DOCKET-50238-28) PORT OPERATING PLAN FOR SAVANNAH, GEORGIA. (First Atomic Ship Transport, Inc., New York). Aug. 10, 1967. 1p. Dep. CFSTI.

42330 (DOCKET-50238-30) PORT OPERATING PLAN FOR SAVANNAH, GEORGIA. (First Atomic Ship Transport, Inc., New York). July 18, 1967. 2p. Dep. CFSTI.

42331 (DOCKET-50238-31) PORT OPERATING PLAN FOR PHILADELPHIA, PENNSYLVANIA. (First Atomic Ship Transport, Inc., New York). July 1965. Revised June 1967. 36p. (FAST-100). Dep. CFSTI.

42332 (DOCKET-50238-41) PORT OPERATING PLAN FOR BOSTON, MASSACHUSETTS. (First Atomic Ship Transport, Inc., New York). Oct. 1965. Revised Oct. 1967. 47p. (FAST-112). Dep. CFSTI.

42333 (DOCKET-50238-44) PORT OPERATING PLAN FOR PIRAEUS, GREECE. (First Atomic Ship Transport, Inc., New York). Feb. 1966. 27p. (FAST-131). Dep. CFSTI.

42334 (NSJ-tr-105) STUDY ON THE INTEGRATION OF A MARINE REACTOR PLANT: THE PROBLEM OF SHIELDING DESIGN. Tanaka, Yoshihisa. Translated from FAPIG (Tokyo), 39: 248-53(Jan. 1966). 17p. Dep. CFSTI.

The integration of a marine reactor plant is increasingly attracting interest. This integration of the plant was investigated from the standpoint of its shield, and the minimizations in the weight and the space involved, and the resulting reduction of the cost were analytically studied. The following results were obtained for a small marine reactor plant: multi-layer shield consisting of water and iron layers is the most light weight and the smallest for use as the primary shield for a reactor core; three to five layers are sufficient in terms of weight for a multi-layer shield; the use of a low-cost shield-layer on the outside is economical; the conventional heat exchangers should be excluded as the optimum shield; as the reactor power output is increased, the weight of shield per kW is decreased; even when a heat exchanger is located outside the pressure vessel, it is possible to reduce the weight of a plant. When marine reactor-plants devoid of fuel-exchange and control systems are developed in the future, the problem of integration may be reduced to the shielding of a reactor core alone. (auth)

42335 RISQUES ATOMIQUES ET ASSURANCE MARITIME. (Atomic Risk and Maritime Insurance). Gaston-Breton, Pierre. Paris, Academie de Marine, 1966. 39p.

Characteristics of risks involved in indemnification of nuclear-based interests are discussed. Legislation in this area is described. The accomplishment of a maritime insurance program and the problems incurred in its execution are discussed. (M.L.S.)

42336 GERMAN NUCLEAR SHIP PROPULSION PROGRAM. Com. Naz. Energ. Nucl., Notiz., 14: No. 6, 62-9(June 1968). (In Italian).

The N. S. Otto Hahn is described; characteristics are tabulated. The principal design data for the pressurized water reactor are listed; this includes core, primary and secondary systems, and reactor dimensions. Design parameters for auxiliary systems are given. The heat exchangers and fuel elements are described; cutaways show the pressure vessel and containment structure. (M.L.S.)

42337 MERCHANT MARINE SHIP REACTOR. (to United States Atomic Energy Commission). French Patent 1,246,458. Filed Jan. 6, 1960.

A merchant marine ship reactor is described having a core comprising multiple extended fuel assemblies containing material fissionable by thermal neutrons, wherein the moderator and coolant is water under pressure and provision is made for passing the moderator through the core in three successive passes. In order to prevent the leakage from the first pass moderator into the second pass moderator a sealing ring is mounted along the top edge of a cylindrical shield surrounding the fuel assemblies and multiple coil springs are located on the ring for maintaining the latter in a sealing position against the shield during movement of the reactor. The core is contained within a pressure vessel which is provided with an annular flange from which the core is suspended and with a top closure to which is connected a means for transmitting hold-down forces to the core. (NPO)

42338 RESEARCH ON MATERIALS FOR THE NERO SHIP-PROPULSION REACTOR PROJECT. Sens, P. F. (Reactor Centrum Nederland, Petten, Netherlands). Atoomenergie Haar Toepass., 10: 121-31(May 1968). (In Dutch).

UB_4 grains in UO_2 fuel elements may serve as burnable poison. The material is prepared in a CO atmosphere and is stable under irradiation below 1650°C. Details of the preparation process and pictures of undamaged as well as severely tested elements are given. Zircaloy-2 samples have been tested in water, steam, and circulating water at temperatures between 300 and 450°C. Quantitative results obtained in water at 340°C with and without a temperature gradient are presented. The corrosion speed is not influenced by a neutron flux. A curve is presented summarizing results on the transition temperature in the ductility of steel as a function of the fast neutron flux. (J.J.t B.)

Rocket and Space Reactors

42339 (AGC-3484) EXPLORATORY RESEARCH ON JET-CONDENSER PERFORMANCE WITH ORGANIC RANKINE-CYCLE POWER SYSTEMS. Garcia, R. (Aerojet-General Corp., Azusa, Calif.). Dec. 19, 1967. Contract AT(04-3)-728. 111p. Dep. CFSTI.

The design and performance of a jet-condenser for a 1 to 15 kW(e) organic Rankine-cycle power conversion system for turbine exhaust pressures of 0.5 to 0.1 psia are described. The purpose is to design a jet-condenser compatible with zero-gravity space environment. The jet-condenser condenses the saturated vapor with subcooled liquid which ensures single-phase flow through a radiator. Mathematical analysis and design and fabrication of experimental units are included. (D.C.C.)

42340 (AI-Memo-7585) NUCLEAR SPACE POWER SYSTEMS. Dieckamp, H. M. (Atomics International, Canoga Park, Calif.). Sept. 1967. 388p.

The history, developmental status, and potential applications of nuclear units in the Systems for Nuclear Auxiliary Power (SNAP) program are reviewed. Reactor space power systems are examined from the selection of the reactor and heat rejection systems through power conversion system design and vehicle integration. Development and operation experience with SNAP 2, 8, and 10 is summarized. Radioisotope space power systems design and application factors discussed include: radioisotope selection criteria, radioisotope capsule design, and design characteristics of radioisotope systems for manned and unmanned space missions. (H.D.R.)

42341 (LA-DC-9331) TURBOPUMP VIBRATION MEASUREMENTS AT CRYOGENIC TEMPERATURES. ISA Paper No. 1.3.1. Washburn, B. W. (Los Alamos Scientific Lab., Schenectady, N. Y.). [1968]. Contract W-7405-eng-36. 4p. (CONF-680617-1). Dep. CFSTI.

Wide band acceleration instrumentation techniques for the Rover ground test facility dual liquid hydrogen turbopump system are described. Information bandwidths to 50 kHz have been utilized to study structural and flow induced vibrations. Transducer environments vary from 530 to 114°R with complex acceleration levels up to 2000 g's pk-pk. (auth)

42342 (SAN-679-8) DESIGN STUDY [OF] ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS. Final Report. King, A. E. (ed.) (Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.). Feb. 1, 1968. Contract AT(04-3)-679. 240p. Dep. CFSTI.

Analytical conceptual designs are presented for purposes of illustrating recent technology for electrical power system components in advanced high-temperature, potassium, Rankine nuclear space power systems in the 0.25 to 10 megawatt range. Data presented are based on extensive backgrounds in the development of high temperature electrical materials, high temperature ac generators and motors, and power conditioning equipment for space application and is intended for application in future nuclear-electric powerplant system or mission studies. Since requirements of the electrical power systems are related to the missions, the design studies were carried out using three representative missions: interplanetary, orbital and planetary base. These were analyzed for the purpose of defining the ranges and types of electrical power needs and corresponding components. (auth)

42343 (UCRL-7036(Pt.6)) TORY II-C INSTRUMENTATION. PART 6 OF THE TORY II-C PROGRAM. Varljen, T. C.; Leger-Barter, G. St. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 1, 1963. Contract W-7405-eng-48. 30p. Dep. CFSTI.

The nuclear and nonnuclear instrumentation systems used to monitor parameters for control of the TORY II-C reactor and air delivery system and for the acquisition of basic performance data are described. The system functions include: direct control and safety (reactor power level and period, core temperature, inlet air temperature, and air flow rate), indirect control (component temperature, pressure, and structural integrity), performance and engineering data, and failure diagnostics calibration, response, and operation of the components and systems are discussed, and the automatic data reduction techniques are described. (H.D.R.)

42344 (UCRL-50004-67-3(Pt.1)) ADVANCED SPACE NUCLEAR POWER PROGRAM. Quarterly Report, July-September 1967. (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 123p. Dep. CFSTI.

RHENIUM ALLOYS AND SYSTEMS — Re-W, creep behavior of, effects of composition and heat treatments on; Hf-Mo-Re-W, surface hardness of, effects of hafnium content on
NUCLEAR AUXILIARY POWER SYSTEMS — kinetics for SPR-4 reactor, use of ZOOM computer code for calculation of; kinetics for SPR-6 reactor, use of ZOOM computer code for calculation of; physics measurements for SPR-5 reactor, description of optimum; physics measurements for SPR-8 reactor, description of optimum; shielding calculations for, description of GEISHA-2 computer code for; configuration of SPR-6 reactor, reference design
THORIUM OXIDES ThO_2 — ThO_2-W, density and weight loss of sintered, effects of heating rate on
TUNGSTEN — creep behavior of, effects of composition and heat treatments on
HAFNIUM NITRIDES — HfN-W, co-vapor deposition of, effects of nitrogen on
URANIUM NITRIDES UN — metallurgical properties of, effects of temperature and pressure on
THERMODYNAMICS — saturation enthalpy and entropy for liquid or gas, calculation of, (E/T)
HEAT TRANSFER SYSTEMS — configuration of SPR-6 reactor, reference design
REACTOR FUEL ELEMENTS — assemblies of SPR-6 reactor, reference design
REACTOR CONTROL SYSTEMS — reactivity response for SPR-6 reactor, description of
HEAT PIPES — configuration of SPR-6 reactor, reference design (D.C.C.)

42345 (UCRL-70863) RANKINE CYCLE SYSTEMS STUDIES FOR NUCLEAR SPACE POWER. Pitts, J. H.; Jester, M. H. L. (California Univ., Livermore. Lawrence Radiation Lab.). May 31, 1968. 24p. (CONF-680802-6). Dep. CFSTI.

From 3rd Annual Intersociety Energy Conversion Engineering Conference, Boulder, Colo.

Two different types of Rankine cycle systems studies are described which can be used to advantage in conjunction with each other. A simple, flexible conceptual design representation gives consistent, general trend results and yet requires minimum expenditure of effort to incorporate changes. After initial design phases are complete, a detailed system representation that includes extensive neutronic and shielding information is used to give final design characteristics of the complete system and components of interest. Some recommendations for future effort are made. (auth)

42346 (UCRL-70984) INVESTIGATION OF PERFORMANCE OF AN OUT-OF-CORE THERMIONIC SPACE POWER SYSTEM. Loewe, William E. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 18, 1968. 24p. (CONF-680802-5). Dep. CFSTI.

From 3rd Annual Intersociety Energy Conversion Engineering Conference, Boulder, Colo.

Conceptual designs of out-of-core thermionic space power generators using heat pipes have been produced for various powers, temperatures, and constraints or parameter values. Since major impediments to in-pile thermionic systems are alleviated or eliminated in the out-of-core concepts, a competitive degree of feasibility and competitive specific masses are adequate to establish the need for emphasis on these systems in future studies and development activities. Feasibility in the six cases shown in conceptual detail appears to be limited only by lithium heat pipe feasibility and a favorable outcome of current technology development of UN, W, and Li materials in the temperature range considered. For example, one man-rated system at 300 KW(e) and 1800°K shows a specific mass of 7.9 kg/KW(e) and will accommodate an 18 m payload at a 50 m distance. (auth)

42347 (UCRL-71004) HEAT PIPE RADIATOR FOR SPACE POWER PLANTS. Werner, Richard W.; Carlson, Gustav A. (California Univ., Livermore. Lawrence Radiation Lab.). May 16, 1968. Contract W-7405-eng-48. 17p. (CONF-680802-4). Dep. CFSTI.

From 3rd Annual Intersociety Energy Conversion Engineering Conference, Boulder, Colo.

A heat pipe radiator which forms the ternary loop of a Rankine power system and furnishes meteoroid protection and fluid isolation of the secondary loop is discussed. The radiator design is usable over a broad range of power and its fabrication is well within current technology. A representative value of specific weight which includes feed lines, return lines, manifolds and heat pipes is ~1.1 kg/kW(e) considered for a 20,000 hour mission at 1100°K with a probability of no critical penetrating hits of 0.99. (auth)

42348 NUCLEAR POWER SUPPLIES FOR SPACE. Polak, H. (North American Aviation International Inc., Brussels). J. Brit. Nucl. Energy Soc., 7: 243-8(July 1968).

The history of the early SNAP systems which led to the development of present programmes is summarized. The current state of the art is reviewed for both heat sources and power conversion systems. Future trends are indicated, and the position of nuclear power sources in relation to other forms of energy for space missions is examined. (UK)

42349 REACTOR FUEL ELEMENT FOR A NUCLEAR ROCKET MOTOR. Rom, Frank E.; Lietzke, Armin F.; Hyland, Robert E. (to National Aeronautics and Space Administration). U. S. Patent 3,378,455. Apr. 16, 1968. Filed Dec. 16, 1964.

A reactor fuel element for rocket propulsion having a plurality of tungsten-clad tungsten 184-uranium dioxide plates mounted in spaced relationship to provide passages for conducting a fluid propellant is described. (Offic. Gaz.)

Process Heat and Desalination Reactors

42350 (TRG-Report-1691) FRESH WATER FROM NUCLEAR POWER WITH THE A.G.R. AND S.G.H.W.R. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 13p. Dep.

An outline is given of the work being done in the U.K. on development of desalination processes. Large scale experiments such as "Seaspray" at Winfrith Heath have provided new information for current plants based on the multi-stage flash distillation technique, but future alternatives are being sought. Dual purpose electricity/freshwater generating systems can provide steam economically using nuclear power. Typical parameters are given for two such systems studied for the AGR and SGHWR. The economics are briefly compared. (UK)

42351 CONSTRUCTION OF NUCLEAR DESALTING PLANTS IN THE MIDDLE EAST. HEARINGS BEFORE THE COMMITTEE ON FOREIGN RELATIONS, UNITED STATES SENATE, NINETIETH CONGRESS, FIRST SESSION ON S. RES. 155, A RESOLUTION TO EXPRESS THE SENSE OF THE SENATE CONCERNING A MEANS TOWARD ACHIEVING A STABLE AND DURABLE PEACE IN THE MIDDLE EAST, OCTOBER 19, 20, AND NOVEMBER 17, 1967. Washington, D. C., Committee on Foreign Relations, 1967. 122p. GPO.

A resolution is discussed before the Senate Committee on Foreign Relations on the construction of three nuclear plants to supply both the Arab countries and Israel with fresh water

and nuclear power. The first plant proposed would supply 450 Mgd of fresh water. Two other plants, one of equal size to the first and one slightly smaller, are also proposed. The combined power output of the three plants would be 6600 MW(e). (H.D.R.)

42352 NUCLEAR DESALINATION. Trevalion, P. A. (United Kingdom Atomic Energy Reactor Group, Risley, Eng.). Desalination, 3: 392-5(1967).

The present state of desalination, especially in the United Kingdom, as reported on and discussed by a number of participants to a symposium is reviewed. A discussion of single and dual purpose desalination plants emphasized the relatively expensive water produced from single purpose systems and the much lower costs possible in large nuclear-powered dual-purpose plants. A ship-borne desalination plant has been designed in the UK especially to meet the water needs of islands or coastal communities which may be unable to afford the cost of individual desalination installations. The price of water from a ship-borne plant was estimated at 26 shillings/1000 gal, lower than prices for water transported from other areas. (BBB)

42353 ENGINEERING DEVELOPMENTS IN THE OSW PROGRAM. Hunter, J. A. (Office of Saline Water, Washington, D. C.). Desalination, 3: 384-91(1967).

Engineering aspects of the research program sponsored by the Office of Saline Water (OSW) are discussed. Processes now being considered by OSW are multi-stage flash distillation, vertical tube evaporation, vapor compression, reverse osmosis, electrodialysis, freezing, hydrate, and ion exchange. At present, the multistage flash distillation (MSF) process appears as the most desirable in meeting very large delivery rates (100 mgpd or higher) at a cost of less than 30 cents per 1000 gallons (3.8 m^3). Dual purpose plants are now in the planning stage where both water and power will be developed using nuclear energy as the heat source. The major program of OSW in the MSF area is, in conjunction with the Metropolitan Water District of California, private utilities, and other government agencies, for the construction and operation of a large desalting plant to be located on a man-made island off the coast of California. This dual purpose plant will be designed for 1800 MW of electric power and 150 mgpd of fresh water. (BBB)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 40177, 40225, 40321, 40331, 40357, 40376, 40508, and 42158.

42354 (AECL-3067, pp 21-8) AECL IN THE CANADIAN NUCLEAR POWER PROGRAM. Gray, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.).

A review of past achievements and a description of present programs in nuclear power plant research and development by the AECL are presented. (D.C.C.)

42355 (ANL-Trans-637) INVESTIGATION OF THE PHYSICAL CHARACTERISTICS OF A WATER-MODERATED WATER-COOLED REACTOR WITH BURNABLE POISONS. Inyutin, E. I.; Karchava, G. A.; Matveenko, V. I.; Morozov, I. G.; Orekhov, Yu. I.; Plaksin, E. A.; Sergeev, Yu. A.; Sidorov, G. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report FEI-88. 15p. Dep. CFSTI.

Physical characteristics of a water-moderated water-cooled reactor are determined from measurements in a zero power assembly. Burnable poisons of gadolinium and cadmium are used for reactivity compensation. The effects of the number of burnable poison rods and their distribution in-core are evaluated. Temperature distributions for elements containing the poison and the effects of the poison on the temperature coefficient of reactivity are determined. (M.L.S.)

42356 (BAW-1322) ADVANCED TEST REACTOR INTERNALS VIBRATION SUMMARY, MAY 1968. Manoll, Roy E. (comp. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). June 1968. Contracts AT(10-1)-1075; 59-3063. 587p. Dep. CFSTI.

For Ebasco Services, Inc., New York.

The systems operational testing of the ATR revealed the vibration of several components within the reactor vessel and excessive vibration of the primary piping. A program of vibration testing and analysis was conducted to take corrective measures to reduce the vibration to an acceptable level and to determine the margin of stability the new fixes achieved as assurance the vibration would not occur in future operations. Calculations, modification drawings, and test data from the vibration program are presented. (H.D.R.)

42357 (BNWL-482) JASON: A REACTOR CELL CODE IN FORTRAN II OR IV. Thompson, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)-1830. 54p. Dep. CFSTI.

JASON is a derivative of the lattice physics code IDIOT, altered to furnish input data required by the ALTHAEA burnup code. It calculates the thermal neutron flux fine structure with the P3 approximation to the Boltzmann transport equation for a system of concentric cylinders limited to 16 regions. Input-output format is shown. A sample problem is solved. (auth)

42358 (BNWL-650) EXPERIMENT DESCRIPTION AND HAZARDS EVALUATION FOR THE PACIFIC NORTHWEST LABORATORY MIXED OXIDE (UO_2-PuO_2) IRRADIATIONS IN EBR-11, TASK A, SUBTASK 1 IRRADIATIONS. Hanson, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 190p. Dep. CFSTI.

A description is given of the proposed program for irradiations in EBR-II of 19-capsule Fast Test Reactor (FTR) fuel subassemblies. The purpose and objectives of the program are: (1) to obtain preliminary fast flux irradiation experience at intermediate and approximately goal exposures with principal candidates for the FTR driver fuel, (2) to obtain irradiation performance data on fuel specimens containing a reference design axial fuel motion restrictor, (3) to obtain fuel specimens irradiated in a fast flux for subsequent evaluation of the fuel and cladding transient performance through irradiation in TREAT, and (4) to provide irradiation experience with fuel specimens whose cladding thickness has been reduced to simulate pessimistic end-of-life conditions. Fuel to be used is hypostoichiometric mechanically-mixed 25% PuO_2-75% UO_2 sintered in a hydrogen atmosphere at 1550°C for 4 hours to yield pellet densities of 90 to 96% TD. Cladding for the fuel pins is Type 304 stainless steel. Design, fabrication, and performance predictions for the fuel specimens, capsules, and subassemblies and a hazards evaluation of the irradiations are presented. (H.D.R.)

42359 (BNWL-SA-1832) EXPERIENCE IN DESIGNING AND OPERATING COMPUTER CONTROLLED REACTOR FACILITIES. Driver, Garth E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 12, 1968. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

Uses of computers at reactor facilities are detailed. Experience with the computer associated with the HTLTR is discussed; the functions of the computer are described. (M.L.S.)

42360 (LA-3965) QUARTERLY STATUS REPORT ON ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX) FOR PERIOD ENDING APRIL 30, 1968. (Los Alamos Scientific Lab., N. Mex.). June 1968. Contract W-7405-eng-36. 19p. Dep. CFSTI.

LOS ALAMOS TURRET REACTOR — control rods for, calibration of; core for, effects on reactivity of rotation of; core for, effects on reactivity of nitrogen flush of; critical mass for, measurement of; core for, power profile of; critical mass for, effects of average core temperature on; instrumentation for, description of in-core

REACTOR CONTROL ELEMENTS — reactivity worth of UHTREX, integral and differential

REACTIVITY — effects of nitrogen core flush on UHTREX, measurement of; effects of UHTREX core rotation, measurement of (M.L.S.)

42361 (NP-17538) UTILISATION OF A RESEARCH REACTOR. TEN YEARS OF APSARA. ([Atomic Energy Commission, Bombay (India)]). [1967]. 82p. Dep.

A complete description of the Apsara (India) Research Reactor is given. This includes: core, instrumentation, and uses. Reactor use for neutron physics and nuclear data measurements is described; nuclear spectroscopy of short-lived nuclei and irradiation studies on chemical compounds are discussed. Agricultural and biological applications are described; data are tabulated. Isotope production, activation analysis, and health physics studies are outlined. (M.L.S.)

42362 (NRL-6709) REACTOR UTILIZATION IN SUPPORT OF RESEARCH AND TECHNOLOGY. Strain, Charles V. (Naval Research Lab., Washington, D. C.). Feb. 14, 1968. 21p.

The radiations generated in a nuclear reactor are useful not only in nuclear physics research but also in many nonnuclear fields of science and technology. A review of present and potential applications of the NRL 1-MW reactor is undertaken with the purpose of encouraging additional utilization of this facility. Neutron activation analysis, a technique capable of assaying very small amounts of many of the chemical elements, is widely used, with examples of its use ranging from the analysis of trace impuri-

ties in highly purified materials to law-enforcement purposes. The sensitivities of the neutron activation technique, expressed as the smallest measurable amount of each chemical element, are included. Other techniques discussed include the measurement of magnetic and crystallographic structure by neutron diffraction, inert and radioactive tracer techniques, the production and use of radioactive sources, radiation effects, and thermal-neutron radiography. (auth)

42363 (ORNL-TM-2254) THE STORY OF "PROJECT AQUARIUM". Kertesz, Francois (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 27p. Dep. CFSTI.

The history of Project Aquarium, the descriptive code name for the design, construction, and operation of a swimming-pool reactor for the 1955 Geneva Conference on the Peaceful Uses of Atomic Energy, is reviewed. The many technical, administrative, and diplomatic problems encountered and overcome in preparing a nuclear reactor for public exhibit for the first time are discussed. After the conference, the reactor was acquired by the Swiss Federal Institute and was named SAPHIR. (H.D.R.)

42364 (ORNL-TM-2295) HIGH FLUX ISOTOPE REACTOR. Quarterly Report, January–March 1968. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). July 10, 1968. Contract W-7405-eng-26. 22p. Dep. CFSTI.

An operations history of the HFIR is given. Spurious Single-channel trips from the safety systems are tabulated. Maintenance and changes in the process systems are listed. Water analyses and demineralizer data are given. (M.L.S.)

42365 (ORNL-tr-1904) LEAKAGE OF THE REACTOR BASIN. Huerlimann, T. (ed.) (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report TM-SR-69. 21p. Dep. CFSTI.

Problems associated with coolant leakage from pools for pool-type reactors are considered. Total time required for the pool to empty, in cases of emergency such as earthquakes, is determined. Heating and cooling effects on partially submerged cores is analyzed in detail. Radiation dose levels for an exposed core are discussed. (M.L.S.)

42366 (SC-CR-68-3571) REACTIVITY CONTRIBUTIONS IN THE GLORY HOLE OF THE SANDIA PULSED REACTOR II. Long, Robert L. (New Mexico Univ., Albuquerque. Dept. of Nuclear Engineering). May 1968. Contracts AT(29-1)-789; 59-2611. 30p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Reactivity worths of various materials are measured as a function of position in the glory hole of the Sandia Pulsed Reactor II (SPR II). Negative reactivity effects are discussed. Effects of glory hole samples on burst behavior are also discussed. (D.C.C.)

42367 INSTRUMENTATION AND CONTROL SYSTEMS OF THE REACTOR ZR-4. Bollok, L.; Leval, F.; Pellionisz, P.; Szabo, F.; Szigeti, B.; Szlavik, F.; Zobor, E. (Zentralforschungsinstitut fuer Physik, Budapest). Atompraxis, 14: 243-4(June 1968). (In German).

The ZR-4 zero-power critical system with a solid homogeneous core was constructed in the Central Research Institute for Physics in Budapest in 1966. It is designed, first of all, for reactor-kinetic and reactor servocontrol research purposes. The principles of construction applied to the development of the measuring and control system of the reactor are discussed, and the most important characteristics and units of this system are presented. Reference is made to the continuously increasing variety of nuclear instruments, control elements, and devices developed and produced in Hungary, as well as to the versatility of a reactor control system composed of these elements. (auth)

42368 EXPERIMENTS ON NATURAL URANIUM GRAPHITE LATTICES BY THE NULL REACTIVITY METHOD. Casali, F. (CNEN, Bologna); Ghilardotti, G.; Montagnini, B. J. Nucl. Energy, 22: 337-54(June 1968).

The measurement of the infinite multiplication factor of natural uranium-graphite lattices in the critical assembly RB-1, Bologna, by the null reactivity method, is described. The procedure which was set up for the execution of the measurements and for their interpretation is given in detail. The error on $k_\infty - 1$ was estimated to be of the order of 2 to 3%, in good experimental conditions. The lattices had been previously tested in the critical assembly Marius, by the substitution method, thus making possible a direct comparison between the two methods. It appears that a fair agreement exists between the two sets of results. (auth)

42369 CART: AN EXPERIMENTAL LOOP IN THE ESSOR REACTOR. Morandi, G.; Scaroni, A. (CISE, Milan). Energ. Nucl. (Milan), 15: 517-31(Aug. 1968).

Design parameters for the CIRENE prototype reactor and the ESSOR reactor are tabulated. The design for the CIRENE Assembly Reactor Tests (CART) loop is given; its use in the ESSOR reactor is described. Characteristics of the main loop components are tabulated; fuel test specimens, to be tested in the CART loop, are described. Safety aspects of the loop are evaluated. (M.L.S.)

42370 FAST NEUTRON SPECTRUM MEASUREMENTS BY THRESHOLD ACTIVATION DETECTORS. Shaalan, M. G.; Hamouda, I. (Atomic Energy Establishment, Cairo). J. Nucl. Energy, 13: 387-8(June 1968).

The fast neutron spectrum at the edge of the core of the 2 MW research reactor, UA-RR-1, was measured by use of the reactions $^{32}S(n,p)^{32}P$, $^{58}Ni(n,p)^{58}Co$, $^{27}Al(n,p)^{27}Mg$, $^{24}Mg(n,p)^{24}Na$, and $^{27}Al(n,\alpha)^{24}Na$. Activities were measured by means of a 400-channel γ-ray spectrometer, a β-γ coincidence system, and 2π and 4π proportional gas flow counters. The results showed a fission energy spectrum, with a deviation for the ^{58}Ni activation. By assuming the fission energy distribution, a cross section of 0.350 b was obtained for the $^{58}Ni(n,p)^{58}Co$ reaction. (UK)

42371 DEVELOPMENT AND CONSTRUCTION OF A SWEEP CIRCUIT FOR THE TRANSPORT OF FISSION PRODUCTS. Stechemesser, H. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 325-30(June 1968). (In German and English).

Some questions relating to the specification, project study, layout and construction of a sweep circuit for transporting fission products from 10 irradiation capsules are discussed. Some typical gas circuit problems are discussed in detail. (auth)

42372 IRRADIATION OF WATER-COOLED FUEL RODS IN BOILING WATER LOOPS. Reichardt, K.; Neumann, M. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 331-7(June 1968). (In German and English).

Boiling water loops have been developed and built for the irradiation of water-cooled fuel elements in FRJ-Z reactor. These loops are distinguished by simple construction, small space requirements, and high operating safety. The fuel rods are cooled by boiling pressurized water by means of a newly developed steam bubbles stabilizer incorporated in the in-pile section. The mechanism of this cooling effect and the design of the loops are described. Reference is also made to some completed and running fuel rod tests. (auth)

42373 NATURAL CIRCULATION LOOPS FOR GAS-COOLED FUEL ELEMENTS. Krug, W.; Kloeckner, W.; Neumann, M. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 338-43(June 1968). (In German and English).

Natural circulation loops have been developed and built for investigations on fuel elements cooled with helium and with CO_2. They are characterised by a simple design, low space requirements and a low cost of the necessary safety measures. The heat generated by the fuel elements is taken off by a natural circulation of high pressure gas in the testing section. The design and operation of the loops are described. (auth)

42374 HELIUM LOOP FOR IRRADIATION EXPERIMENTS ON FUEL PINS IN THE FR2 REACTOR. Bojarsky, E. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 10: 344-50(June 1968). (In German and English).

The irradiation facility at the Karlsruhe Nuclear Research Center is used for special investigations on fuel pin specimens within the framework of the Fast Breeder Project. At an operating helium pressure of about 30 kgf/cm^2, gas temperatures between 100 and 200°C, and gas velocities up to 130 m/s, it is possible to attain a heat transfer coefficient of up to 0.75 W/cm^2 deg. This makes it possible to maintain with high accuracy by automatic control a constant fuel pin surface temperature at values between 400 and 750°C and to control heat flux densities of up to 400 W/cm^2 on the pin. The considerations governing the choice of coolant and the design and operation of the entire facility with particular emphasis on the numerous safety features are described. (auth)

42375 DEVELOPMENT OF IRRADIATION CAPSULES FOR COATED PARTICLES. Bundesmann, G. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 309-15(June 1968). (In German and English).

The principles of temperature control for the irradiation capsule and the safety measures required are described. It is shown that waiving certain requirements in a first experimental stage may lead to a step development of a highly sophisticated irradiation facility. The advantage of this method is that first provisional results can be obtained with a simple rig at a very early date. (auth)

42376 KFKI: REACTOR OF THE CENTRAL RESEARCH INSTITUTE OF PHYSICS. Szabo, Ferenc. Energ. Atomtech., 21: 104-8(Jan.-Feb. 1968). (In Hungarian).

A brief survey is given of operating experiences with the WWR-type reactor of the Central Research Institute for Physics of the Hungarian Academy for Sciences. Some of the experiments are described. Reactor design parameters are tabulated. (M.L.S.)

42377 FAST NEUTRON REFLECTION BY STEEL RODS INTRODUCED IN A WATER REFLECTOR. Elmeshad, Yahia (Institutt for Atomenergi, Kjeller, Norway). Nukleonik, 11: 156-7 (1968).

A simulation of a base core reactor in NORA water-reflected and water-moderated UO_2-fueled zero-power thermal reactor is accomplished by the insertion of steel rods in the reflector region. A theoretical analysis of the reactivity by a simple one-dimensional, two-group diffusion model is presented. Results show positive reactivity contribution due to fast neutron reflection by the steel rods. The regionwise macroscopic constants are presented. (D.C.C.)

42378 TECHNOLOGICAL RESEARCH AT THE RCN. van der Laken, R. A. (Reactor Centrum Nederland, Petten, Netherlands). Atoomenergie Haar Toepass., 10: 143-7(June 1968). (In Dutch).

In emergency cases the heat present in a ship-propulsion reactor has to be discharged without the use of any mechanical or electrical energy. The use of submerged double pipes is described in which secondary cooling water is evaporated and then condensed in an air-cooled condenser and recirculated. Experiments to test the device are reported. Stopcocks for water are tested for leaking at 140 atmospheres pressure and 300°C. Burnout of fuel elements due to boiling of the cooling water is simulated with an electrically heated steel tube, diameter 12 mm, situated inside a glass tube. Water at a pressure below 7 atmospheres is present between the tubes. This provides visual and photographical observation of the boiling process. High pressure experiments are under development. (J.J.t B.)

42379 MEASUREMENT AND ANALYSIS OF THE COUPLED CORE COHERENCE FUNCTION IN A TWO NODE SYMMETRICAL REACTOR. Seifritz, W.; Albrecht, R. W. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 11: 149-54(1968).

Experimental determinations of the coherence function in the KFZ Argonaut Reactor with both a ring core loading and a two slab core loading in which the detector efficiency is quite high are reported. The experimental data are compared to a mathematical model for a two node, symmetrical, zero power nuclear reactor. Parameters in the model include the subcriticality of an individual zone and the phase shift of the time delay density function for coupling between zones. These parameters are determined from experiment and the subcriticality is found to be in reasonable agreement with calculations as well as with an independent measurement. It is found that the mean time delay is relatively independent of the form of the time delay density function for this system with a two slab loading. The value of the mean time delay is shorter than that predicted by thermal neutron wave theory and much shorter than the time delay for a typical Argonaut Reactor quoted in the literature. 9 references. (auth)

42380 EFFECT OF DELAYED NEUTRONS ON REACTOR EXCURSIONS WITH RAMP REACTIVITY INSERTION. Canosa, Jose (General Electric Co., Pleasanton, Calif.). Nukleonik, 11: 131-9(1968).

The maximum net reactivity introduced by an unlimited ramp insertion is obtained analytically, taking delayed neutrons into account, and for a general temperature-dependent reactivity feedback of the reactor. A clear, quantitative criterion is obtained in terms of the reactor and excursion parameters that gives the conditions under which a ramp reactivity insertion causes prompt criticality. The methods of singular perturbation theory of differential equations are used to obtain a quantitative description of the first power burst resulting from the ramp reactivity insertion. The results are in good agreement with a numerical solution of the point kinetics equations with six delayed neutron groups and temperature-dependent feedback. (auth)

42381 NOISE MEASUREMENTS IN ANNA REACTOR. Szechter, Andrzej; Chwaszczewski, Stefan; Mikulski, Andrzej T. (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 13: 663-76 (1968).

The experiments on noise analysis performed in the ANNA reactor are described. Some known experimental techniques and new methods based on the measurement and analysis of suitably chosen conditional probabilities of neutron counts are discussed. Short descriptions of measuring equipment and some remarks on experimental procedures are given. Some aspects of data elaboration are briefly discussed. 14 references. (auth)

42382 THE TEMPERATURE DEPENDENCE OF ^{235}U RESONANCE FISSION RATE IN HOMOGENEOUS SYSTEMS. Yasuno, Takehiko (Japan Atomic Energy Research Inst., Ibaraki, Japan). Nukleonik, 11: 155-6(1968). (In German).

Equations describing the temperature dependence of the fission rate of a ^{235}U-probe are developed for a homogeneous system. The temperature dependence is expressed in terms of a ratio of fission rates at two different temperatures. (M.L.S.)

42383 METHOD FOR CHECKING NEUTRON MEASURING CHANNEL WHICH IS INSTALLED IN A SWIMMING POOL REACTOR. Runge, E. G. PTB Mitt., 78: 193-5(June 1968). (In German).

In changing the measuring quantity at the position of an ionization chamber by removing a solid or fluid absorber it is possible to test a complete neutron measuring channel of a nuclear reactor without shutting it down. For a swimming pool reactor a cup mounted underneath an ionization-chamber in the direction to the core is described. The water contained therein can be displaced by means of compressed air. The missing shielding effect of the water causes the ionization current to increase. The effect to be expected has been calculated and confirmed by experiment. (auth)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 40345, 40480, 41017, 41082, 41086, 41087, 41093, 41094, 41099, 41124, 41125, 41127–41130, and 42158.

42384 (AI-AEC-12695) THERMAL GRADIENT EFFECTS ON STRESS-RUPTURE BEHAVIOR OF THIN-WALLED TUBING. Shively, Jon H. (Atomics International, Canoga Park, Calif.). June 25, 1968. Contract AT(04-3)-701. 45p. Dep. CFSTI.

The results of stress-rupture tests of internally heated and pressurized thin-walled tubes of Type 304 stainless steel are presented. The tubes were immersed in high-purity sodium at 1200°F and at a flow rate of 20 ft/sec. A heat flux of 10^6 Btu/ft^2-hr passed through the wall. The heat flux was applied in three modes: steady; 6-min on, 6-min off; and 1-min on, 1-min off. The purpose of these tests is to examine the separate and combined effects on creep behavior of stainless steel fuel rod cladding from: internal NaK pressurization; thermal gradient through the cladding wall; thermal cycling; rate of thermal cycling; and mass transfer. Control tests without internal heating showed that NaK versus helium pressurization and flowing sodium have no effect on the creep behavior. Steady internal heating also has little apparent influence on creep behavior even though evidence of mass transfer was found on the surface. Cyclic heating produced large changes in the microstructures, strain profiles, strain at failure, and the stress-rupture life. Both the reduced life and the attendant strain are explained semi-quantitatively in terms of a ratcheting mechanism using primary creep. These results support the concept that ratcheting of the cladding due to reactor load variations is a distinct possibility and that this must be considered in designing fuel elements for long life and high power density operation. (auth)

42385 (ANL-Trans-645) REACTIVITY INTEGRAL THEOREM FOR A CRITICAL REACTOR. Stumbur, E. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Tekhnicheskii Institut). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report FEI-77. 8p. Dep. CFSTI.

A theorem is proven which correlates the integral of reactivity coefficients ("statistical weights") by the volume of a critical reactor with the property gradients of the medium or for a reactor which consists of homogenous regions with the reactivity coefficients at the boundaries. The proof is given on the basis of a general kinetic equation with the energy dependence of all quantities. The only limitations of the theorem are the requirements of the convexity and homogeneity of the external boundary of the reactor. (auth)

42386 (BNWL-SA-2003) NEUTRON FLUCTUATIONS AT FULL POWER. Sheff, James R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 15, 1968. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

The theory of neutron fluctuations in a nuclear reactor operating with feedback effects is developed. The principal method used was the Langevin approach which was extended to allow iterative solutions of the nonlinear feedback equations. The theory was applied to one and two feedback coefficient models, and calculated results are shown for the first order solutions which result from a particularly desirable linearization of the equations. It is shown that to first order the feedback spectra can be written as being proportional to the modulus squared of the feedback transfer function plus corrections. As a direct result of the insight provided

via the Langevin approach, a particular linearized solution to the probability balance set of equations was also obtained again verifying the transfer function modulus squared concept. (auth)

42387 (KR-126, pp 279-97) INTRODUCTION TO THORIUM FUEL CYCLES. Roberts, J. T. (Oak Ridge National Lab., Tenn.).

Current efforts in the development of reactors using Th fuel are listed along with some of the reasons for interest in and advantages of Th-fueled reactors. The decay chains for and reprocessing of Th fuels started with ^{235}U and $^{239}Pu-^{241}Pu$ are contrasted. The fuel cycle of the molten salt-breeder reactor is described briefly since it is unlike other Th and U fuel cycles. (B.L.M.)

42388 (MIT-334-94) EFFECT OF REACTOR IRRADIATION ON SANTOWAX OM AND WR. Mason, E. A.; Lee, M. L.; Brewer, S. T.; Bley, W. N. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). June 1968. Contract AT(38-1)-1968. 386p. Dep. CFSTI.

Irradiations of the terphenyl mixtures, Santowax OM and WR, were made in the M.I.T. In-pile Loop Facility at temperatures ranging from 300°C (572°F) to 427°C (800°F). These potential coolants for nuclear reactors were irradiated while flowing through a stainless steel in-pile loop installed in a special fuel element in central position (Fuel Position 1) of the MITR. Steady-state operating conditions were maintained by continually removing coolant samples from the loop and feeding processed coolant to the loop. The coolant samples were processed using a High Boiler (HB) distillation procedure to remove HB. The distilled terphenyls and Low and Intermediate Boilers (LIB) were returned to the loop along with fresh makeup. The dose rates to the terphenyl coolant due to fast neutrons and gamma-rays were measured using adiabatic calorimeters. Resonance and threshold foils were used as a check on the calorimetric measurements of the fast neutron fraction of the total dose rate. Three steady-state low temperature (300°C) irradiations of Santowax OM were made at different terphenyl concentrations to determine the apparent reaction order for radiolysis and the rate constants for degradation by radiolysis. Six autoclave pyrolysis experiments were made, three with unirradiated Santowax WR and three with irradiated Santowax WR. Procedures for estimating coolant makeup rates in organic-cooled reactors are presented and discussed. Physical property measurements included density, viscosity and number average molecular weight. (auth)

42389 (N-68-16227) DYNAMIC PRESSURE LIMITS FOR FLAT PLATES AS RELATED TO NUCLEAR FUEL ELEMENTS. Smith, Roger L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 29p. (NASA-TN-D-4417). CFSTI.

Tests with air or helium flowing over single flat plates were performed at room temperature to determine the values of dynamic pressure required to cause plate failure. Failure was defined as a deflection greater than 0.010 inch (0.0254 mm). The ranges of the plate dimensions used are given. The plate materials selected were lead, aluminum, copper, and steel, which provide ranges of Young's modulus of elasticity from 2×10^6 to 30×10^6 psi (1.38×10^6 to 20.7×10^6 N/cm^2), and of Poisson's ratio from 0.288 to 0.42. Gas density varied from 0.025 to 1.0 pound per cubic foot (0.4 to 16 kg/m^3). The experimental results were compared with an existing theoretical analysis which predicts dynamic pressure for sudden, complete plate collapse. The experimental results agree with the theoretical prediction for the effect of the material properties, but disagree with the prediction for the effect of the plate and flow-channel dimensions. The large amount of experimental data scatter and the disagreement of these data with the theoretical prediction may be caused by leading-edge effect, flutter, turbulence, or other unknown factors. (auth) (STAR)

42390 (NSJ-tr-101) MERITS OF THE NONLINEAR-SCALE PERIOD METER IN COMPROMISING SCRAM-DELAY AND FLUCTUATION. Furukawa, Tomozo; Wakayama, Naoaki. Translated from Nippon Genshiryoku Gakkaishi, 8: 486-9(Sept. 1966). 8p. Dep.

A description is made of the relationship between the fluctuation caused by the process of detection of the neutron flux during the normal operation and the response or delay time to the trip action of the excessively short period in the nonlinear period meter, which has a larger gain in the range of normal period for starting-up the reactor and a smaller gain in the range of abnormally short period. This type of period meter is shown to be convenient for the operator in reading the scale in the range of normal operation, and in addition it has an advantage over the conventional period meter in the compromise of fluctuation and trip-delay. (auth)

42391 (ORNL-TM-2262) POTENTIAL VORTEX FLOW ADJACENT TO A STATIONARY SURFACE. Kidd, G. J. Jr.; Farris, G. J. (Oak Ridge National Lab., Tenn.). June 20, 1968. Contract W-7405-eng-26. 38p. Dep. CFSTI.

The equations describing the flow produced by the interaction of a potential vortex with a stationary surface are solved by means of similarity transformations. In this analysis, where the only restriction is that the flow be similar, solutions are obtained for tangential Reynolds numbers up to 4.75. The numerical method employed is based on a recently proposed technique for solving ordinary differential equations with asymptotic boundary conditions. (auth)

42392 (ORNL-tr-1968) RESULTS OF THE HIGH TEMPERATURE IRRADIATION OF GRAPHITE AND PYROLYTIC CARBON IN THE DOUNREAY FAST REACTOR, SCOTLAND. Delle, W.; Stoecker, H. J. Translated by D. M. Hewette II (Oak Ridge National Lab., Tenn.), from paper presented at the Conference of the Workers Committee on Carbon of the German Ceramic Society e.V., Basel, Switzerland, October 13, 1967. 18p. Dep. CFSTI.

Numerous types of graphites, pyrolytic graphite, and coated particles are held in a cylindrical graphite magazine in the Dounreay Fast Reactor for fast neutron irradiation. Each of the seventeen magazines is contained in a ready made niobium capsule. The capsules are contained in a rod shaped vehicle located in a DFR fuel channel. Graphite samples are positioned in the outer holes of the magazine while the inner hole contains the SiC monitors and reference samples of PGA graphite. The temperature and neutron flux distributions are presented. Dimensional measurements obtained for various graphites irradiated at 1300°C are also presented. (D.C.C.)

42393 (RISO-M-732) RECOMMENDATIONS FOR SAFEGUARDS INSPECTION OF UNIRRADIATED MTR FUEL ELEMENTS. Kunzendorf, H.; Loevborg, L. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar. 1968. 15p. (R-16-68). Dep.

On the basis of experiments with assemblies of MTR fuel elements of the type used in the Danish research reactor DR 2, a set of procedures, based on the use of a portable γ-spectrometer, for safeguards inspection of these and similar fuel elements are drawn up. It is estimated that the method will at least make it possible to detect the absence of an amount of the ^{235}U in the fuel element equal to the normal content in one fuel plate. (auth)

42394 (RT/FI-(68)8) ABSORPTION CROSS SECTION MEASUREMENTS IN SAMPLES CONTAINING BURNABLE POISONS. Ferrari, T.; Martinelli, R.; Santandrea, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 27p. Dep.

Absorption cross sections of samples containing B_4C, ZrB_2, and Gd_2O_3 dispersed in Al_2O_3 were measured in the RANA reactor. Experimental apparatus, measurement method, and results are presented for samples with different material composition and grain size, both before and after irradiation. Measurements were also made on two samples containing Al_2O_3 only. (H.D.R.)

42395 (RT/FI-(68)9) THE CIAP-1D CODE. Dal Bono, I.; Leproni, V.; Salvatores, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 19p. (PRV-r-(67)14). Dep.

The CIAP-1D-code is described. The code, written in FORTRAN-II for the IBM-7094, utilizes one-dimensional multigroup theory for calculating neutron importance functions for both real and adjoint neutron fluxes. The basic equations are given. Input and output formats are included. A sample problem is solved. (M.L.S.)

42396 (SC-T-68-1532) INTERRELATION OF TWO DETECTORS IN A NUCLEAR REACTOR. Dalfes, Abdi; Beliard, Lucien; Cazemajou, Jean; Froelicher, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from report CEA-R-3221. 51p. Dep. CFSTI.

An abstract was previously prepared from the original language and appeared in NSA as 21: 44823. (B.G.D.)

42397 (TID-24602) INTERACTION OF LIQUID SODIUM WITH 304 STAINLESS STEEL. Final Report. Moberly, John W.; Barlow, Malcolm; Garrison, Marvin C.; Planting, Peter J. (Stanford Research Inst., Menlo Park, Calif.). Jan. 31, 1968. Contract AT(04-3)-115. 28p. Dep. CFSTI.

The effects of liquid Na environment on 304 stainless steel are analyzed by electron microscopy. Effects of exposure time and temperature are evaluated. (D.C.C.)

42398 (WAPD-TM-727) ANNULAR FLOW AIR-WATER MIXING TESTS. Peterson, A. C. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1968. Contract AT(11-1)-Gen-14. 54p. Dep. CFSTI.

Two-phase eddy diffusivities of mass are measured in the wide

direction of a 3.0 × 0.100 inch vertical duct, with upflow of both air and water, using a dye tracer in the water and a He tracer in the air. An experimental technique is used which divides the flow into nine transverse tracks, and the flows and tracer concentrations of each phase in each track are measured. The data are analyzed using the diffusion equation for a single phase applied to each phase separately. The two-phase eddy diffusivities of mass are up to 40 times larger than those obtained during single-phase flow. (auth)

42399 SPATIAL INSTABILITIES IN A TWO-ZONE REACTOR. Jeffers, D. E. (Manchester Univ., Eng.); Crosbie, R. E.; Lynn, J. W. J. Brit. Nucl. Energy Soc., 7: 259- (July 1968).

Stability criteria for xenon-induced spatial oscillations in a reactor composed of two coupled cores are derived. (auth)

42400 AECL IN CANADA'S NUCLEAR POWER PROGRAMME. Gray, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Eng., 13: 498-501(June 1968).

The areas of interest and responsibility of the AECL are described. The research and development policy which is discussed involves collaboration with the universities, with utilities, and with industry. (UK)

42401 EFFECT OF FUEL CLADDING ON THE RESONANCE INTEGRAL IN LATTICES. Fukai, Y.; Mizuta, H. (Nippon Atomic Industry Group, Kawasaki, Japan). J. Nucl. Energy, 22: 355-70(June 1968).

The resonance integral of ^{238}U for Al, Zr, or Fe clad metal or oxide fuelled lattices was accurately calculated by an IBM-7090 code, RICM, by direct numerical integration of the neutron slowing down due to ^{238}U and cladding nuclei. The results are compared with those obtained by the narrow resonance and the wide resonance approximations. In order to investigate the spatial aspect of the problem, the exact values of the Dancoff corrections for three-region lattices were calculated by the method of Fukai, and an evaluation was made of the calculation methods based on the void and the homogeneous approximations. A new method for the treatment of the cladding is suggested which essentially reduces it to a two-region problem by use of a modified Dancoff correction. The method is simple, and is more accurate, as the slowing down in the cladding is taken into account. (UK)

42402 MULTIGROUP FAST FISSION FACTOR TREATMENT IN A THERMAL REACTOR LATTICE. Stefanovic, D. B. (Boris Kidric Inst. Nucl Sciences, Belgrade). J. Nucl. Energy, 22: 329-36(June 1968).

A multigroup procedure for studies of fast fission effects in the thermal reactor lattice and the calculation of the fast fission factor is developed. The Monte Carlo method and the multigroup procedure are combined to calculate the fast neutron interaction and backscattering effects in a reactor lattice. A set of probabilities calculated by the Monte Carlo method gives a multigroup spectrum of neutrons coming from the moderator and entering the fuel element. The assumptions normally adopted in defining and calculating the fast fission factor are thus avoided, and a new definition including the backscattering and interaction effects in a reactor lattice is obtained. (auth)

42403 NUCLEAR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,419,735. Filed Oct. 9, 1964.

A fuel assembly comprising multiple vertical sheathed fuel pencils closed at each end by a plug is described. The brazed plugs are provided with horizontal bores through which connecting rods are passed. Preferably the assembly has symmetry of revolution about a central fuel pencil, some of the rods being disposed radially and connecting the plug of the central pencil to at least one other plug, the other rods connecting at least two plugs situated at the same distance from the central pencil. (IIB)

42404 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,214,056. Filed Jan. 20, 1959.

A fuel element assembly is described which comprises stacks of clusters of elongate sheathed fuel elements, support plates for locating the elements at both ends, spacers for the support plates, and a graphite sleeve supporting the plates and spacers from one end and allowing expansion at the other end. The assembly is provided with means for coupling an adjacent assembly. (IIB)

42405 NUCLEAR REACTOR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,444,181. Filed May 19, 1965.

A fuel assembly comprising pencils of fissile material which are canned and grouped in a cluster is described. The can of each pencil is provided with helical fins with uniformly spaced notches for inserting the secant fins of adjacent pencils and for interlocking the fins. The assembly is fitted with a retaining collar for supporting the pencils at each end of the assembly. (IIB)

42406 NUCLEAR REACTOR CORE. (to United Kingdom Atomic Energy Authority). French Patent 1,422,684. Filed Jan. 26, 1965.

A nuclear reactor core comprising multiple fuel assemblies of concentric cylindrical fuel elements is described. The fuel elements comprise eccentric regions having different infinite multiplication factors and are mounted for rotation with respect to each other to afford control of the reactor by interchange of the positions of the regions. At least some of the elements comprise a region containing a nuclear fuel and a region containing a neutron absorbing poison. Preferably each of the elements comprises a region containing a nuclear fuel and a region containing a moderator. (IIB)

42407 MANIPULATING DEVICE FOR USE IN A NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,392,096. Filed Mar. 24, 1964.

A manipulating device for use in a nuclear reactor is described. The device consists of a structural support member, an assembly engaging member with means for extending the assembly engaging member laterally outwardly from and retracting it inwardly towards the support member, and means possessed by the assembly engaging member for supporting a fuel assembly at the lower end. (IIB)

42408 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to Societe Belge pour l'Industrie Nucleaire "Belgo-Nucleaire" S.A.). French Patent 1,329,610. Filed Feb. 23, 1962.

A fuel element assembly is described which comprises a plurality of elongate parallel fuel elements, a member which supports the elements and centers the assembly in the reactor vessel, and a control rod in the form of a tube or a cage with a servomechanism. Two different constructions are given. (IIB)

42409 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Aktiebolaget Atomenergi). French Patent 1,444,426. Filed July 22, 1965.

A fuel element is described comprising a canned fuel body provided with a thermally insulating layer between the body and the can. The intermediate layer consists of a space which is evacuated or filled with an inert gas. The space is formed by longitudinal grooves provided in the surface of the fuel body facing the can. (IIB)

42410 FUEL ELEMENT AND ALARM DEVICE FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,455,955. Filed July 19, 1965.

A fuel element is described having two compartments, one of them containing the fissile material and the other being filled with a gas having a pressure which exceeds the operating pressure of the coolant. The partition wall is provided with a whistle, which is blown by the gas if the sheath of the element is damaged and leaking occurs. A sound detector gives an alarm signal. The same principle is used in a device for signalling overheating of the reactor if its cooling system breaks down. In this case the device comprises two compartments being filled with gas at different pressures. The compartments are connected by a narrow channel in which the whistle is mounted and which is closed by a plug. The plug melts at the highest admissible temperature. (IIB)

42411 NUCLEAR REACTOR. (to Babcock and Wilcox Co.). French Patent 1,340,876. Filed Aug. 24, 1962.

A nuclear reactor having a core comprising fuel elements arranged side by side and adapted to operate with upward flow of coolant from inlet to outlet ends is described. Each element consists of a number of longitudinally extending sheathed fuel pins or rods of circular cross-section. Only some of the elements are provided with hold-down means. These elements are arranged to co-operate with laterally adjacent fuel elements to resist coolant flow force. (IIB)

42412 IMPROVEMENT IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,230,890. Filed July 21, 1959.

A fuel element consisting of a fuel member enclosed by a sheath and adapted to be stacked in a column with similar elements by male and female fittings secured to the ends of the sheath is described. One end of the fuel member contains breeder material. The breeder material is welded or keyed to the fuel member so that they can expand together. (IIB)

42413 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Babcock and Wilcox Ltd.). French Patent 1,156,133. Filed Aug. 27, 1956.

A fuel element including a fuel bar enclosed in a sheath is described. The bar is provided with a longitudinal axial channel for fission gas release. The bar consists of a number of separate cylindrical sections, the surface at one end of each section being convex and the surface at the other end being concave. Each section of the bar is provided with angularly displaced diametrical holes about the longitudinal axis to prevent large temperature gradients. (IIB)

42414 CERAMIC FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to General Dynamics Corp.). French Patent 1,395,526. Filed Nov. 12, 1962.

A ceramic fuel element assembly is described. The assembly consists of multiple stacked hollow ceramic moderator blocks with defined inner cavities, a spine comprising multiple stacked ceramic moderator pieces centrally disposed within the cavity to form an annular space, multiple ceramic nuclear fuel rods spaced apart within the annular space, and a vertical support assembly for the nuclear reactor core. (IIB)

42415 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,318,083. Filed Mar. 20, 1962.

A fuel element comprising fissile material enclosed in a tubular sheath is described. The ends of the sheath are closed by end caps sealed to the sheath by circumferential edge welds. In order to protect this weld from mechanical damage it is enclosed by a shroud member which is joined to the sheath by a second circumferential edge weld. This weld is protected by two adjacent circumferential ridges projecting radially by a least the amount of projection of the weld. (IIB)

42416 NUCLEAR FUEL ASSEMBLY. (to Babcock and Wilcox Co.). French Patent 1,376,449. Filed Dec. 13, 1963.

A fuel assembly which comprises a bundle of parallel fuel pencils to be disposed in the coolant channel of a nuclear reactor is described. The bundle is composed of a majority of primary pencils having a uniform concentration of fuel from end to end and of a minority of secondary pencils having a central portion, preferably extending over a third of the length, which does not contain any fuel or has a diminished fuel concentration. The secondary pencils are disseminated symmetrically in the bundle. (IIB)

42417 NUCLEAR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,415,685. Filed Aug. 28, 1964.

A cluster-type fuel assembly is described comprising multiple sub-assemblies of canned fuel rods. The sub-assemblies are parallel and arranged in concentric circles. A mechanical connection between the sub-assemblies consists of rings between the circles. The rings are longitudinally spaced and concentric with the circles. Each ring is formed with short lateral extensions in contact with the canned fuel rods and secured by brazing. (IIB)

42418 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,246,699. Filed Feb. 2, 1960.

A fuel element assembly is described which comprises stacks of clusters of elongate sheathed fuel elements, support plates for locating the elements at both ends, spacers for the support plates, and a graphite sleeve supporting the assembly from one end and allowing expansion at the other end. Each of the support plates is provided with a central aperture so that the assembly can be threaded together with similar assemblies for lifting and lowering the assemblies as a single unit out of and into the coolant channel of the reactor. (IIB)

42419 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to Babcock and Wilcox Co.). French Patent 1,251,894. Filed Mar. 24, 1960.

A fuel rod assembly enclosed in a container forming a coolant channel is described. The container is provided at one end with an internal, removable closure member penetrated by a nozzle. The container, the closure member and the nozzle are fitted with co-operating locking members. (IIB)

42420 NUCLEAR FUEL ASSEMBLY SUPPORT. (to Commissariat a l'Energie Atomique). French Patent 1,478,480. Filed Mar. 3, 1966.

A fuel assembly is described which consists of a casing which bears at its lower end a narrowed cylindrical extension piece for insertion into a cylindrical bore of a supporting member. The extension allows upward flow of coolant into the assembly. The extension piece is surrounded by a cylindrical skirt which communicates with the coolant channel and which is locked at the upper end. The locks are released as soon as the coolant flow is stopped. (IIB)

42421 NUCLEAR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,391,095. Filed Jan. 21, 1964.

A nuclear fuel assembly which comprises multiple parallel sheathed fuel rods is described. The rods have a star-shaped cross-section preferably with three or four branches. The outer extremities of adjacent branches are interconnected by a curved border-line which is concave with respect to the exterior of the rod. The assembly is enclosed in a container, the inner wall of which is provided with convex portions matched to and spaced apart from the concave portions of the fuel rods to form a coolant channel having parallel walls. (IIB)

42422 NUCLEAR FUEL ASSEMBLY. (to Groupement Atomique Alsacienne Atlantique). French Patent 1,339,594. Filed July 30, 1962.

A nuclear fuel assembly is described which comprises a number of sub-assemblies stacked to a column and centered in the coolant channel of a nuclear reactor by means of male and female members projecting axially from the top respectively, from the bottom of adjacent subassemblies. Each subassembly consists of multiple parallel sheathed fuel rods disposed in circular array around the common axis of an upper and a lower supporting disc. All rods are secured to the lower disc by means of screwbolts. The upper ends of some of the rods are screwed down as well to the upper disc, the upper ends of the remaining rods sliding freely in apertures provided in the upper disc. (IIB)

42423 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,367,170. Filed Aug. 14, 1963.

A fuel assembly is described which comprises a column of neutron moderating material, a bore hole in the column, an inner cylindrical member mounted coaxially within the bore hole to define an annular coolant channel, and an annular fuel member disposed in the channel. The fuel member comprises an annular column of spines. Each spine has threaded on to it one or more tubular fuel bodies and is joined by links to the adjacent spines so as to allow relative articulation between the spines. The links are positioned relative to one another in such a manner that the coolant follows a helical flowpath in the coolant channel. (IIB)

42424 FUEL ELEMENT ASSEMBLY FOR A BOILING NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,304,386. Filed Oct. 24, 1961.

A fuel element assembly is described which comprises an outer container tube, multiple fuel elements arranged in concentric circles inside the tube, and device for causing coolant to flow outwardly radially. The flow device is a central tube with perforations and spaced annular trays extending outward to a diameter less than the inner diameter of the container tube. (IIB)

42425 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to General Electric Co., Ltd.). French Patent 1,229,274. Filed July 2, 1959.

A fuel element assembly is described which comprises an elongate carrier of moderating material which is adapted for insertion into the coolant channel of the reactor and which is provided with at least one duct for the coolant flow. Each of the ducts contains groups of elongate fuel elements. The elements are located in the duct with their longitudinal axes extending transversely to the duct and have a cross-section giving low resistance to flow, such as an oval or lenticular cross-section with the major dimension extending in a direction parallel to the longitudinal axis of the duct. Various constructions are given. (IIB)

42426 NUCLEAR FUEL ELEMENT ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,228,913. Filed Mar. 16, 1959.

A fuel element assembly is described which comprises a vertical cylindrical housing containing multiple parallel elongate fuel elements and which is closed by an upper and a lower plate both provided with apertures. The elements are closed by end plugs which are provided with an external central stem. The stems at both ends of an element have free sliding engagement with aligned apertures of the plates. The distance between the plates exceeds the length of the fuel elements by an amount which permits full expansion of the elements when raised to the operating temperature of the reactor. (IIB)

42427 ROD CLUSTER FUEL ASSEMBLY SUPPORT STRUCTURE. (to United Kingdom Atomic Energy Authority). French Patent 1,304,319. Filed Oct. 21, 1961.

A support structure for a fuel assembly of the type which comprises a closely spaced lattice of parallel disposed sheathed fuel rods is described. The structure is fabricated from strip material troughed transversely at intervals. The structure is assembled with the lengths of the strip material intermediate the troughs juxtaposed in pairs to form webs of double thickness with the throughs coming together to define a number of spaced openings bounded with a single thickness of strip material for receiving the fuel rods. (IIB)

42428 NEUTRON ABSORPTION IN SOME MATERIALS USED IN REACTOR DESIGN. Lungren, Goeran. Uppsala, Univ. of Uppsala, 1968. 10p.

Thesis.

A review is given on 4 earlier published papers on the following matters: effective total and resonance absorption cross section for Zircaloy 2 and Zr; resonance integral for Nb; resonance absorption of metallic uranium and uranium oxide; and energy dependence of ^{232}Th capture cross section in the energy region 0.1 to 3.4 eV. (Sweden)

42429 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Physikalische Studiengesellschaft Duesseldorf mbH). French Patent 1,165,106. Filed Nov. 2, 1956.

A fuel element which consists of a shaped body containing U-238 as such or in the form of a compound with natural or enriched admixtures of U-235 is described. In order to prevent the undesirable formation of Pu-239, the body is provided with a coating of Th or of Th-compounds. Preferably the body and the coating are made porous, the pore volume being at least 5%. (IIB)

42430 STRUCTURE FOR SUPPORTING A STACK OF FUEL ELEMENTS IN A VERTICAL COOLANT CHANNEL OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,169,274. Filed Mar. 8, 1957.

A supporting structure for fuel elements which are stacked to a column in a vertical coolant channel of a nuclear reactor is described. The structure comprises a number of rods made of a material having a high resistance to compression and a low neutron absorption coefficient, and which are superimposed with interposition of laterally and horizontally extending circular brackets made of a material having a high resistance to bending or shearing stresses and also having a low neutron absorption coefficient. The fuel elements are tubular, each element resting on one of the brackets and coaxially surrounding the rod that is supported by the bracket. (IIB)

42431 NUCLEAR REACTOR FUEL ASSEMBLY. (to Societe Grenobloise d'Etudes et d'Applications Hydrauliques). French Patent 1,375,047. Filed June 18, 1963.

A tubular fuel assembly which is supported at its lower end by two spaced grids which are disposed in the core tank of the reactor is described. In operation a coolant flows upwards through the tubular casing. In order to stabilize the assembly against lifting due to the forces exerted by the ascending coolant the lower end of the casing is closed by a bottom plate and the part of its lateral wall between the supporting grids is provided with apertures, allowing radial feeding of the coolant from a surrounding reservoir into the assembly. Preferably the coolant is discharged radially from the top of the assembly by means of a similar device. (IIB)

42432 FUEL ELEMENT FOR NUCLEAR REACTOR. (to General Dynamics Corp.). French Patent 1,494,618. Filed Sept. 28, 1966.

A fuel element is described comprising an elongate generally cylindrical fuel body enclosed by a metallic container, the fuel body having an outer diameter sufficiently less than the inner diameter of the container so as to provide a thermal insulating gap there between throughout the operating range of temperatures of the element, and spacer means disposed intermediate the fuel body and the container to maintain said insulating gap, which is preferably filled with a thermally insulating gas. Preferably the spacer means comprise a plurality of protuberances extending from the container and engaging the fuel body. If the element is intended for use in a water cooled pulsing nuclear reactor, graphite cylinders are provided at either end of the fuel body acting as top and bottom reflectors. (IIB)

42433 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,441,778. Filed May 3, 1965.

A fuel element is described which comprises an elongated tubular fuel body including discrete fuel particles dispersed within a graphite matrix, each particle having a center of fuel, which is coated with a material being effective to retain therewithin at least 99% of the fission products, and means for positioning the fuel body in the core of the reactor so that the outer surface of the graphite matrix is in direct contact with the flowing coolant. Preferably the matrix contains 30 vol % of fuel particles having a diameter of about 700 μ and a coating of pyrolytic carbon. In order to improve the heat transfer, localized turbulence is created in the coolant stream by a woven cloth which is affixed to the outer surface of the fuel body, containing between 8 and 12 threads per cm aligned in the direction transverse the coolant flow. (IIB)

42434 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs GmbH). French Patent 1,278,594. Filed Feb. 4, 1961.

An elongate fuel element is described which is intended to be stacked with other similar elements in a column in the coolant channel of a reactor, the element having at one end an axial recess and at the other end an axial projection for engagement with similar means on the adjacent elements. Into said projection a body, e.g., a sphere or a cylinder, is inserted, which consists of neutron absorbing material and which forms practically a black body for the capture of neutrons. Preferably said body is surrounded by one or more layers of a material having a high neutron diffusing or dispersing cross-section. (IIB)

42435 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,468,994. Filed Dec. 7, 1965.

A fuel element comprising a tubular casing which contains the fuel and provides a path for a gaseous coolant flow is described. The casing is divided into two parts, the upper part being provided with locking means for fastening the element to a supporting plate, and the lower part being provided with means for engagement with a centering grid. In order to prevent deformation or rupture of the element when the centering grid is raised to its final position, the upper and the lower part of the casing are interconnected by a safety member which collapses under a force which is less than that which would cause deformation of the element. A space is provided beneath the fuel in the upper part of the casing for lodging the lower part if the safety member breaks down. (IIB)

42436 NUCLEAR FUEL BEARING BODIES. (to United Kingdom Atomic Energy Authority). French Patent 1,437,478. Filed Feb. 26, 1965.

Nuclear fuel bearing bodies such as fuel elements or entire reactor cores which are particularly adaptable to manufacture by processes involving automation are described. The bodies are composed of a number of lengths of extruded nuclear fuel material which are wound into a number of convolutions as a multi start helix about a common axis. Preferably the body is formed as a number of superimposed layers of convolutions, each layer being separated from the adjacent layer by spacers extending in a direction parallel with the common axis. The spacers may be hollow to allow the introduction of neutron absorbing members. (IIB)

42437 FUEL ELEMENT FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,378,431. Filed Dec. 11, 1963.

A fuel element is described which is intended to be stacked with other similar elements in the coolant channel of a nuclear reactor, the element having at one end a locating and load-bearing cup and at the other end a locating and load-bearing cone. At least the cone-engaging surface of the cup is of metallic material. The cone is in two portions, the cup-engaging portion being of refractory material such as graphite, magnesia or alumina, the body portion, securing the cup-engaging portion to the element, being of magnesium base alloy. (IIB)

42438 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,459,595. Filed Dec. 14, 1965.

A fuel element is described comprising an elongate sheath, which contains at least two and no more than five groups of stacked fuel pellets, the groups being separated from each other by spacing members which are sealed to the inner wall of the sheath. A void is provided between the upper pellet of each stack and the nearest spacing member to allow for longitudinal expansion of the pellet stack relative to the sheath during operation of the reactor. In the void a compression spring is inserted between the spacing member and an insulation disc, which rests on the upper fuel pellet. (IIB)

42439 NUCLEAR REACTOR. (to General Dynamics Corporation). French Patent 1,336,372. Filed July 31, 1962.

A high temperature, gas-cooled, graphite-moderated reactor having a plurality of fuel elements, each of the elements comprising a container consisting of neutron moderating material having a low permeability to fission products, a moderator-containing support spine within the container, a plurality of fuel com-

pacts consisting of an intimate mixture of fuel and moderating material disposed around said spine, and selected thermal neutron absorbing material having thermal resonance bands at energies above 0.3 eV disposed within the container, the amount of said material being sufficient to impart a substantial prompt negative contribution to the temperature coefficient of reactivity of the reactor at temperatures in excess of 1200°C, thereby improving the safety characteristics of the reactor. (IIB)

42440 IMPROVEMENT IN FUEL ELEMENT END CLOSURE. (to EURATOM). French Patent 1,475,174. Filed Apr. 6, 1966.

In a known method for securing the sheath of a fuel element to the plug by which the end of the element is closed, the plug is provided with an annular groove and the wall of the sheath is forced into this groove by magnetic forming. However, the tightness of such a joint at the operation temperature is illusive, the materials of the sheath and the plug having different coefficients of expansion. The improvement consists in surrounding that part of the sheath which covers the groove with an annulus, composed of a metal having the same coefficient of expansion as the material of the plug, after which the magnetic forming is effected. (IIB)

42441 IMPROVEMENT IN NUCLEAR REACTORS. (to Stein and Roubaix). French Patent 1,427,709. Filed Oct. 17, 1964.

A nuclear reactor, the secondary circuit of which is provided with an independent superheater, located between the steam generator and the turbine is described. The improvement consists in regulating the pressure at the entry of the superheater in accordance with the pressure required at the entry of the turbine and not, as usual, in accordance with the pressure prevailing at the exit of the generator. Two different methods of regulation are given. (IIB)

42442 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,402,587. Filed July 29, 1964.

A fuel element is described, the sheath of which is sealed by end-plugs fitting in the ends of the sheath, the element being provided at both ends with bearing faces for stacking of such elements in a column in the coolant channel of the reactor. The wall thickness at the end regions of the sheath is greater than the wall thickness intermediate this region. Each end-plug is provided with an outwardly extending skirt, abutting the end of the sheath, the edges of the skirt and the sheath being joined by a sealing weld. This weld is machined in such a manner as to define an annular flat or conical bearing face for the adjacent element. In this way the use of complementary attached end fittings such as nose cones and sockets is eliminated so that less neutron absorbing material is introduced into the core and a greater length of fissile material is included in the coolant channel. (IIB)

42443 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Skoda Oborovy Podnik Plzen). French Patent 1,480,296. Filed Mar. 29, 1966.

The cylindrical fuel element is provided at its upper end with a number of parallel peripheral grooves in which radially extensible and retractable segments are lodged, the grooves and segments being shaped in such a way as to restrict the radial movement of the segments. Various constructions are given. (IIB)

42444 FUEL ASSEMBLY STRINGS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,378,779. Filed Jan. 9, 1964.

A fuel assembly string comprising a base support, a plurality of stacked fuel assemblies, a tie rod extending from said base support through the stack of fuel assemblies, support means adapted to be secured in the coolant channel of a reactor and located at an end of said tie rod for suspension of the base support, the fuel assemblies and the tie rod within the channel, and resilient means reacting between the support means and the stack of fuel assemblies to exert a tensile force on the tie rod is described. Preferably the support means comprises a tubular member threaded over the end of the tie rod and the resilient means is a compression spring located between the tubular member and the stack of fuel assemblies. (IIB)

42445 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,305,252. Filed Nov. 14, 1961.

An elongate fuel element provided with end coupling means for connecting the element to similar elements, the coupling means allowing the elements to be charged into the reactor as an assembly and discharged from the reactor individually, is described. The coupling means comprise at one end of the element a pin located transversely to the longitudinal axis of the element and at the other end a bayonet-type socket. In a modification the coupling means comprise a boss at one end of the element and spring-loaded chuck jaws at the other end. (IIB)

42446 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,265,090. Filed Oct. 3, 1961. 1st Addition 80,450.

A fuel element for a fast reactor, which element is filled with fuel to 50–90% of the available fuel volume and has an outer sheath with a circular cross-sectional shape having flattened parts in each quadrant of the circle which are in direct contact with an inner sheath, the clearance between the sheaths being filled with a thermally conducting material, is described. In a modification individually sheathed fuel sections are arranged end to end in a common outer sheath. In an assembly comprising several elements in spaced parallel relationship the outer sheaths of the elements are provided with radially directed longitudinal fins, the extremities' adjacent elements being interengaged. The cluster of elements is surrounded by a tubular open-ended casing with interposition of a yieldable liner which is provided on both sides with longitudinal ribs, the ribs on one side contacting the said fins and the ribs on the other side contacting the inner wall of the casing. (IIB)

42447 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Winnett Boyd Ltd.). French Patent 1,257,647. Filed Sept. 2, 1959.

A fuel element for use in a horizontal position in a nuclear reactor, comprising a cylindrical casing of neutron moderating material containing a number of wafers of fuel material arranged with their planes normal to the axis of the casing is described. In order to obtain an efficient heat transfer from the wafers to the wall of the casing the periphery of each wafer and the surface of the casing conform exactly over at least a third of the periphery of the wafer so that when the casing is horizontal the conforming parts lie in contact with each other. Preferably the inner surface of the casing is of circular section, the periphery of each wafer comprising three equal arcs of circles, each arc having the same radius as the inner surface of the casing and the centers of the arcs being so displaced that the maximum perpendicular distance between parallel tangents to the perimeter of the wafer is less than the internal diameter of the casing. In a modification the wafers are circular and the inner wall of the casing has a multiple arc surface. (IIB)

42448 FUEL ELEMENT FOR NUCLEAR REACTOR. (to English Electric Co. Ltd.). French Patent 1,176,380. Filed May 31, 1957.

A fuel element for use in a reactor in which the elements are stacked in the coolant channel is described. The element is provided with a plurality of struts, being movable between a retracted position, where they allow free movement of the element within the channel, and an extended position, where they engage a supporting ledge or abutment means in the channel so as to provide an independent support either for the element itself or for the next element to be lowered into the channel. The struts are automatically moved to the extended position as they approach the supporting ledge or abutment means. Various constructions are given. (IIB)

42449 DEVICE FOR SUPPORTING AN ASSEMBLY OF FUEL ELEMENTS IN A NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,297,472. Filed Aug. 10, 1961.

A device for releasably suspending a cluster of fuel elements contained in a housing from a supporting structure disposed above the core of a nuclear reactor is described. The device comprises a body part carried by the upper end of the housing, a latch member carried by the body part and engagable with the supporting structure, a latch actuating member for moving the latch member into engaging and disengaging positions with the support structure and means for retaining the latch actuating member in the engaged position. (IIB)

42450 FUEL ELEMENT STRING FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,327,572. Filed July 2, 1962.

A string of elongate fuel elements stacked one upon another and provided with means whereby the string can be lifted and lowered as a unit, with the lowermost element suspended from said means and the other elements supported on said lowermost element, the means being removable from the elements by an operation remote from the elements, is described. Preferably each element is provided with two flexible open-ended tubes extending at diametrically opposed positions along the length of each element, said means comprising a flexible cable lapped to form a sling between two lifting ends which pass through the open-ended tubes, the lowermost element being suspended in an upright attitude in the loop of the sling. (IIB)

42451 FUEL ELEMENT FOR NUCLEAR REACTOR AND METHOD FOR ITS MANUFACTURE. (to General Electric Co.). French Patent 1,239,850. Filed Nov. 6, 1959.

A fuel element having a high heat conductivity is described which comprises a pair of external metal cladding layers and a central metal layer with fuel-containing cells, which have ratios of length, measured normal to the element surface, to minimum width, measured parallel to the element surface, of between 1.0 and 5.0. The element can be manufactured by perforating a metal plate, placing said plate adjacent a first metal cladding plate, introducing a nuclear fuel into the perforations, placing a second metal cladding plate adjacent the fuel containing plate, and rolling said plates to bond them together and to compact the fuel. Preferably the perforations are spaced as closely as possible to one another in order to realize 80% open area. In this way the active nuclear fuel volume is about 50% of the volume of the whole fuel plate. A tubular fuel element may be produced by rolling the fuel plate into tubular form and welding the seam. (IIB)

42452 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Kernforschungsanlage). French Patent 1,452,344. Filed Oct. 20, 1965.

A cylindrical or tubular fuel element is described for use with water- or metal-cooled reactors, in which the fuel particles consist of carbides, oxides or nitrides of fissionable materials coated with BeO, C, or carbides and are contained in a can which is closed in vacuum-tight manner, the can being made of a corrosion-resistant metallic material. Preferably the coated fuel particles are mixed with a filler in powder form or in the form of beads, consisting of a material which has a good heat conductivity, the neutron flux density being brought to its optimum value by adjusting the ratio of mixing between the particles and the filler longitudinally of the element. The spaces between the solid constituents are preferably filled with an inert gas, which is under a pressure being approximately equal to the pressure of the coolant at the operating temperature of the element. (IIB)

42453 FUEL ASSEMBLY FOR NUCLEAR REACTOR. (to Alfa-Laval AB). French Patent 1,428,261. Filed Mar. 4, 1965.

A fuel assembly is described which consists of a central main coolant channel, multiple parallel sheathed fuel rods annularly disposed around the channel in spaced relation in one or several rows, a perforated protective jacket surrounding the outer row of fuel rods, and means for guiding the coolant from the lower side of the assembly through the central channel. Guiding means are arranged to cause the coolant to be given a flow direction which has a component parallel to the longitudinal direction of the assembly and a component perpendicular to the direction, so that the latter component is smaller than the former. In a modification the fuel rods are replaced by cladded balls of fuel which are kept assembled by an inner and an outer perforated tube. Various other constructions are given. (IIB)

42454 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to Societe Nationale d'Etude et de Cotruction de Moteurs d'Aviation). French Patent 1,232,350. Filed Apr. 30, 1963. 4th Addition 83,868.

A fuel element assembly is described which comprises multiple parallel elongate sheathed fuel elements for a vertical coolant channel of a nuclear reactor. In order to improve the heat transfer from the elements to the coolant the sheaths of the elements are interconnected by longitudinal coolant deflecting plates which are helically twisted with respect to their central lines which are parallel with the axes of the elements. (IIB)

42455 NUCLEAR REACTOR CORE STRUCTURE. (to United Kingdom Atomic Energy Authority). French Patent 1,299,400. Filed Sept. 5, 1961.

A core structure is described which has fuel assemblies each comprising a tubular coolant-conducting container, multiple individually removable fuel sub-assemblies, a latching device to regulate the sub-assemblies and a second latching device for retaining the container in the core structure. The first and second latching devices are operated sequentially. (IIB)

42456 NUCLEAR REACTOR. (to Societe Francaise des Constructions Babcock and Wilcox). French Patent 1,305,135. Filed Nov. 9, 1961.

A nuclear reactor is described. The reactor consists of a core of moderator material surrounded by a layer of reflector material and provided with fuel elements each comprising a can of impermeable graphite and containing nuclear fuel and active carbon, to absorb gaseous fission products. A portion of the can immediately adjacent the absorber material and arranged to be positioned beyond the reflector material is stainless steel. The fuel is enclosed in short cylindrical containers of permeable graphite having enlarged ends arranged to position the containers within the can. Each end of the can is provided with three longitudinal equiangularly spaced grooves, of 60 degrees each. The can is provided with an outer sheath of stainless steel. (IIB)

42457 DEVICE FOR INSERTION AND WITHDRAWAL OF FUEL ELEMENTS INTO AND OUT OF THE CORE OF A NUCLEAR REACTOR. (to English Electric Co., Ltd.). French Patent 1,446,571. Filed Aug. 20, 1965.

A grappling device for fuel elements is described. The device consists of a head which is provided at its lower end with a number of movable jaws for engagement with a bearing surface in the upper part of the element. Preferably this surface is spherical, the outer edges of the jaws having a circular shape. Various constructions are given. (IIB)

42458 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to Societe Belge pour l'Industrie Nucleaire). French Patent 1,329,611. Filed Feb. 23, 1962.

A fuel element assembly is described having a hollow cylindrical support to which the fuel elements are fixed, and around which support a plurality of rows of fuel elements are arranged enclosing only partially said support. Preferably the elements are arranged around the support in a horseshoe-like structure, the external contour of which is formed by four adjacent sides of a hexagon. (IIB)

42459 SUPPORT STRUCTURE FOR NUCLEAR FUEL ASSEMBLY. (to Westinghouse Electric Corp.). French Patent 1,285,670. Filed Apr. 4, 1961.

A support structure for a nuclear fuel assembly which is composed of a plurality of vertically disposed parallel elongate fuel elements is described. The structure comprises an elongate rigid vertical frame, horizontal upper and lower support plates, and an intermediate horizontal grid. The fuel elements are disposed in aligned apertures in said plates, one end of the elements being attached to one of the plates and the other end of the elements being in free sliding engagement with the other plate to permit full longitudinal expansion of the elements when raised to the operating temperature of the reactor. Lateral movement of the elements is prevented by the grid which is in close engagement with their center section. Various constructions are given. (IIB)

42460 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,383,186. Filed Nov. 19, 1963.

A fuel element is described having a reservoir volume of free space, concentrated at a selected position inside the protective sheath, preferably at one or both ends of the element. During manufacture the element is evacuated and filled with a gas containing a radioactive tracer gas which has a relatively long half-life, e.g., He with 0.06% of Kr-85, a concentration of the gas being established at the selected position. In this way it is possible to test the element for leakage by means of a radioactivity detector, the concentration of the tracer gas providing a signal which is much larger than that due to the background radiation of the fuel material. Three different constructions are given wherein the reservoir volume is provided within a heat insulation disk interposed between the fuel and the end cap of the element. (IIB)

42461 NUCLEAR FUEL ELEMENT. (to United Kingdom Atomic Energy Authority). French Patent 1,379,962. Filed Jan. 2, 1964.

A fuel element is described comprising a tubular sheath, a stem extending axially within the sheath, nuclear fuel segments located on the stem leaving radial clearance between the segments and the sheath, and washers which are interposed between the segments and which engage the stem and the sheath to locate the stem radially with respect to the sheath. Preferably the element comprises two concentric tubular sheaths defining between them an annular fuel chamber, the washers engaging both the inner and outer sheaths. An axial annular space between one end of the fuel and the adjacent end-plug is provided with a spring member with one end bearing upon the fuel, and with a restraint device to resist axial expansion of the fuel, which device is constituted by two telescoping members, one of them engaging the spring and the other engaging the end-plug. Preferably the sheaths and the washers are made of Nb. (IIB)

42462 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,253,119. Filed Apr. 5, 1960.

A fuel element comprising, in a protective jacket, a stacked array of fuel discs is described. In order to reduce the temperature gradient between internal and superficial points of the discs they are coated, preferably by electric deposition, with a metal of high thermal conductivity and are arranged in close face-to-face contact. Preferably a filling of metal, which is liquid at the

operating temperature is provided between the jacket and the stacked array of coated discs. In a modification, the filling of metal is omitted, a good thermal contact with the jacket being obtained by stacking in the jacket coated discs having a slight spherical curvature and then pressing the discs to flatten them to be tight fitting in the jacket. (IIB)

42463 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Kernforschungsanlage). French Patent 1,463,490. Filed Jan. 12, 1966.

A fuel element is described comprising a nuclear fuel (e.g., U-carbide) and a sheath between which is interposed a layer of low-melting metal (e.g., Na) which contains powdered Zr or Zr-alloy. (NPO)

42464 CLOSURE WELDING OF NUCLEAR REACTOR FUEL ELEMENTS HAVING A VERY THIN SHEATH. (to EURATOM). French Patent 1,423,478. Filed Feb. 4, 1965.

A method of closing an end of a flexible metal sheath of a nuclear fuel element having a thickness smaller than 0.1 mm is described. The method comprises the steps of: inserting the fuel in the sheath in such a manner that the end of the sheath extends beyond the end of the fuel, inserting into the sheath and over the fuel a metal plug having a raised peripheral edge until the sheath projects beyond the edge of the plug, mounting a metal ferrule around the end of the sheath in correspondence with the edge of the plug whereby the sheath extends beyond the ferrule and the edge of the plug, and, finally, welding the end of the sheath and the adjoining parts of the ferrule and the plug edge together. A sufficient part of the welding heat is dissipated in the ferrule and the plug to prevent breakdown of the sheath, their thicknesses being substantially larger than that of the sheath. (NPO)

42465 CLOSURE WELDING OF NUCLEAR REACTOR FUEL ELEMENTS. (to United Kingdom Atomic Energy Authority). French Patent 1,429,797. Filed Apr. 6, 1965.

Fuel elements of the pin-type are described. In order to close the end of the thin-walled sheath an end-cap is inserted into the sheath, the outer surface of the cap contacting the inner wall of the sheath, the cap partly extending beyond the end of the sheath, which is then welded to the cap by peripheral argon-arc welding. After this the contacting walls of the cap and the sheath are deformed together (e.g., by swaging) in such a manner as to form a tube with a narrow bore. The element is then evacuated and filled with helium through this channel after which the open end of the tube is closed by helium-arc welding. (NPO)

42466 CLOSURE METHOD FOR THE ENDS OF NUCLEAR FUEL ELEMENTS OF THE DISPERSION TYPE. (to United Kingdom Atomic Energy Authority). French Patent 1,411,641. Filed Oct. 16, 1964.

A fuel element is described comprising a fuel bar, which consists of particles of fritted ceramic fissile material (e.g., UO_2) dispersed in a matrix of fritted ceramic non-fissile material (e.g., BeO), the longitudinal surface of the bar being sheathed with a ceramic non-fissile material (e.g., BeO). The element is closed by hot-pressing (e.g., 1450°C, 140 Kg/cm^2, 1 hr) a disc, consisting of the same material as that of the matrix, against the end of the fuel bar, with intercalation of a second disc composed of a mixture of powder of this material in a non-fritted condition with a vitreous binder (e.g., 62% SiO_2, 20% Al_2O_3, 18% MgO). (NPO)

42467 CLOSURE WELDING OF NUCLEAR REACTOR FUEL ELEMENT SHEATHS. (to United Kingdom Atomic Energy Authority). French Patent 1,431,278. Filed Mar. 18, 1965.

In securing the end-caps to the sheath of a nuclear fuel element by argon-arc welding it is known that the adjoining edges of the end-cap and the sheath are provided with a V-shaped groove. In order to obtain a greater depth of weld fusion and in consequence a greater leak barrier the V-shaped groove is connected at its bottom with an annular groove in such a manner as to form a Y-shaped groove. (NPO)

42468 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,339,744. Filed Oct. 29, 1962.

A fuel element is described comprising a ring of enriched non-metallic fissile material (e.g., UO_2) enriched to 2% U-235. The fuel ring is supported at its inner periphery by depleted non-metallic fissile material (e.g., UO_2) containing only 0.43% U-235, preferably in the form of a ring in order to retain a free space for the gaseous fission products. The enriched fissile material is enclosed in a sheath of stainless steel, preferably filled with He. (NPO)

42469 CLUSTER FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,322,621. Filed May 16, 1962.

A cluster fuel element is described wherein the individual fuel members are spaced apart at their ends by grid support structures. At least one of the grids is fabricated from strip material troughed transversely at intervals and assembled with the lengths of the strip material intermediate the troughs juxtaposed in pairs to form a relatively large member of relatively thin webs not inherently resistant to dishing stresses. The troughs come together to define a number of spaced openings bounded with single thickness of strip material and provide end location for the fuel members the juxtaposed lengths of the strip material being secured together remote from the opening. To reinforce the relatively thin webs against dishing stresses a relatively small number of relatively thick webs formed from portions of strip material is disposed radially from about the center of the grid structure of the periphery. (NPO)

42470 NUCLEAR FUEL CAN. (to Magnesium Elektron Ltd.). French Patent 1,455,574. Filed Nov. 18, 1965.

A can for sheathing U is described in which the inner part of the wall is a Mg-base alloy containing Al (e.g., Mg with 0.002 to 0.1% Be, 0.25 to 1.1% Al, 0 to 0.44% Ca or with 0.25 to 3.0% Al, 0.01 to 1.0% Si or with 0.05 to 0.3% Al, 1.0 to 1.7% Si) and the outer part of the wall, together with cooling fins, is a Mg-base alloy having a higher creep resistance than the inner part (e.g., Mg with 0.05 to 0.5% Zr, 0.15 to 0.5% Mn or with 0.1 to 1% Zr, 0 to 0.25% Mn and/or 0 to 0.01% Be). (NPO)

42471 CLOSURE OF FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,446,308. Filed Oct. 8, 1964.

The fuel element is closed by an end-plug which is provided with a narrow longitudinal bore for evacuation of the element. After the evacuation the bore is obturated by a pin driven into the bore by means of a piston, the vacuum being maintained during this operation. (NPO)

42472 NUCLEAR FUEL ELEMENT ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,270,969. Filed Oct. 20, 1960.

A fuel element assembly is described comprising an upright-disposed tubular coolant conducting housing, grid members formed by intersecting webs disposed edgewise to the coolant flow to form apertures, the sheathed elongate fuel elements extending through the apertures suspended from the uppermost grid member, and small lateral projections extending from the sides of the webs to locate the elements in the apertures. The apertures are disposed in the lattice in such a way that the coolant free-flow cross section per fuel element increases progressively from the center of the lattice to the boundary thereof. (NPO)

42473 CLOSURE OF FUEL ELEMENTS FOR NUCLEAR REACTORS HAVING A SHEATH OF FRITTED ALUMINIUM. (to Centro Informazioni Studi Esperienze. EURATOM). French Patent 1,486,856. Filed July 15, 1966.

In order to obtain a tight joint between the sheath and the end-plug of the fuel element, both being composed of fritted aluminium powder (Al-Al_2O_3), they are pressure welded by circumferential hammering at a temperature of 500°C causing intermetallic diffusion. The sheath and the end-plug are surrounded by an annulus of fritted aluminium and an aluminium tube on which the hammering is performed during 5 sec. with a shock-frequency of 3000 to the minute. (NPO)

42474 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,259,772. Filed July 13, 1960.

A fuel element assembly is described which comprises multiple elongate sheathed fuel elements disposed in a cluster with the individual elements being spaced laterally from one another by spacing members. The ring shaped fuel charges contained in the elements are divided into end-shaped sections by disks of heat-insulating non-fissile material disposed in register with the spacing members while the spaces within the ring shaped charges are filled with solid cylinders of the same non-fissile material. Preferably the spacing members are in the form of grids. The elements are located in the openings of the grids and are centered by lateral projections carried by the grids. (NPO)

42475 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,248,261. Filed Feb. 4, 1960.

A fuel element is described which comprises a fuel slug canned with a nuclear grade graphite sleeve, a graphite cylinder surrounding the sleeve, and multiple longitudinal graphite fins extending radially between the cylinder and the sleeve. The fuel is encased within a cladding of metal having a low neutron absorption cross section before being canned within the sleeve. In order to permit full longitudinal expansion of the fuel when raised

to the operating temperature of the reactor the ends of the cladding are sealed by low neutron absorption cross-section metal end caps in spaced relation to the fuel slug. If no cladding is used the sleeve is closed by refractory end caps spaced from the fuel. The outer surface of the sleeve is coated with a refractory metal carbide having a high corrosion resistance. (NPO)

42476 NUCLEAR FUEL ASSEMBLY. (to Societe Anglo-Belge Vulcain-S.A.). French Patent 1,399,849. Filed June 3, 1964.

A nuclear fuel assembly comprising multiple parallel fuel pins which are secured to a support plate is described. The means to secure each pin to the plate comprise a peg projecting axially from one end of the pin with a hollow end portion, a shoulder between the peg and the pin, a hole in the support plate, at least a portion of the peg extending completely through the hole to an extent limited by the shoulder, and a pinched deformation of the hollow portion of the peg which engages the support plate on the side remote from the shoulder. (NPO)

42477 FUEL ELEMENT CLUSTER FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,365,533. Filed May 31, 1963.

A cluster of fuel elements having sheaths of moderating material and disposed in parallel array is described. The elements are supported in contact with one another except at interspaces for coolant flow over the elements by two end support members and inter-braced by an intermediate grid member. The sheath of each of the elements consists of two portions extending along a common longitudinal axis. The adjacent ends being sealed into the grid member to produce a cluster of sealed joints between lengths of fuel element sheaths. The end support members are secured in tied relationship by one or some of the elements of the cluster. The remaining elements are axially unrestrained so that expansion of the unrestrained elements which can be greater or less than that of the tied elements can be accomodated. (NPO)

42478 NUCLEAR FUEL ASSEMBLY. (to Groupement Atomique Alsacienne Atlantique). French Patent 1,337,401. Filed July 30, 1962.

A nuclear fuel assembly which comprises a number of sub-assemblies stacked to a column in the coolant channel of a nuclear reactor is described. Each sub-assembly consists of a supporting disc and a plurality of parallel sheathed fuel rods disposed in regular, e.g., circular or hexagonal, array around the axis of the assembly. Each supporting disc is provided with a plurality of bore holes, the holes in adjacent discs being aligned. The lower end of each fuel rod is secured to the support disc by means of a screw bolt disposed in the upper part of a bore hole, its upper end sliding freely in the lower part of a bore hole of the supporting disc of the adjacent sub-assembly. The supporting discs are interconnected by vertical peripheral spacing members having a length which slightly exceeds that of the fuel bars. (NPO)

42479 NUCLEAR FUEL ASSEMBLY END SUPPORT. (to Societe Anglo-Belge Vulcain S. A.). French Patent 1,392,932. Filed Apr. 22, 1964.

An upper end fitting to secure a fuel assembly to a fuel support grid is described. The end fitting comprises a threaded spindle to penetrate an aperture in the grid, a shoulder to limit this penetration, a threaded nut to be screwed onto the spindle, the co-operating threads on the nut and the spindle being discontinuous and capable of disengagement by partial rotation of the nut to permit axial displacement of the nut, and locking means to counter rotation of the nut on the spindle. (NPO)

42480 NUCLEAR INSTRUMENTATION SYSTEM FOR PWR. Kawashima, Katsuhiko; Iwakishi, Akira (Mitsubishi Electric Corp., Tokyo). Mitsubishi Denki Lab. Rep., 42: 725-31(May 1968). (In Japanese).

Described are nuclear instrumentation equipment manufactured by the Mitsubishi Electric Corporation, problems concerning the use of BF_3 proportional counters for a source range channel, a common use method of a CIS signal both in intermediate and power range channels, and test results of this equipment in a research reactor. In connection with them, a recent nuclear instrumentation system for a PWR is also discussed briefly. (auth)

42481 METHOD OF REPLACING FUEL ELEMENTS IN A NUCLEAR REACTOR. (to Sulzer Freres Societe Anonyme). French Patent 1,277,778. Filed Jan. 17, 1961.

A method of replacing an elongate fuel element which is inserted in a can having an opening through which a coolant is supplied to and relieved from the can is described. The removable can is inserted in the moderator unit of a nuclear reactor. A radiation shield is placed on top of the moderator unit. The loading method comprises removing the can containing the element which must be changed from the respective passage, removing the element from the can while retaining the can within the radiation shield, inserting a new-element into the can and placing the can into a vacant passage in the moderator unit. A pressure testing device and a washing device are introduced into the can before the new element is inserted in order to check and clean the can. (IIB)

42482 CLOSURE WELDING OF NUCLEAR REACTOR FUEL ELEMENT SHEATHS. (to United Kingdom Atomic Energy Authority). French Patent 1,355,939. Filed Apr. 10, 1963.

A method for effecting welding between annular end-caps and a tubular sheath of a fuel element is described. The welding method comprises the positioning of each end-cap in the corresponding open end of the sheath so that the outer end of the wall of the end-cap projects outwardly beyond the end of the sheath. A weld is made in at least the annular space bounded by the end edge of the sheath and the projecting outer periphery of the end-cap. The finished weld overlaps the projecting portion of the end-cap. Correct positioning of the end-caps may be obtained by providing internal annular shoulders in the sheath. (NPO)

42483 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,480,401. Filed Apr. 1, 1966.

A fuel element comprising a sheathed stack of wafers consisting of a ceramic fuel is described. In order to prevent deformation of the element the wafers are located on a central bar having a high mechanical resistance and maintaining its strength at the operating temperature of the element. If the ceramic fuel is based on UO_2 or PuO_2 the bar is composed of a refractory oxide, e.g., Al_2O_3, MgO, ZrO_2 or SiO_2; if the fuel consists of U-carbide, the bar is composed of graphite. (NPO)

42484 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,359,742. Filed Feb. 25, 1963.

An elongate fuel element is described comprising a bar of fissile material containing Pu (e.g., a ternary alloy of 75% U, 15% Pu, 10% Mo), an inner sheath contacting the fuel bar consisting of a material which doesn't form an eutectic with Pu (e.g., V, W, Cr, Ti, Zr, preferably Nb), and an outer sheath consisting of a material having a high mechanical resistance and a high corrosion resistance which is impermeable to fission gases (e.g., stainless steel). The space between the inner and the outer sheath is filled with a material having a high heat conductivity which is liquid at the operating temperature of the element (e.g., Na or Na-K-eutectic). (NPO)

42485 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,446,889. Filed Sept. 14, 1965.

A fuel element which comprises a fissile U-carbide, sheathed with a can of stainless steel is described. The fuel is spaced from the can by an intermediate layer consisting of a material which prevents the diffusion of the U-carbide into the wall of the can (e.g., W, Ta, Nb, Mo of a thickness of 0.025–0.05 mm). (NPO)

42486 IMPROVEMENT IN A FUEL ELEMENT FOR NUCLEAR REACTOR. (to General Electric Co.). French Patent 1,314,168. Filed Jan. 24, 1962.

A fuel element is described which comprises a fuel material initially containing ^{235}U and a thermal neutron fissionable material, and which upon neutron irradiation is subject to a non-uniform thermal neutron flux distribution including local regions of relatively high thermal neutron flux. The improvement consists in disposing in the local regions a second fuel material initially containing ^{232}Th and a thermal neutron fissionable material which has a value of macroscopic thermal neutron absorption cross section Σ_a initially no less than that of the first fuel material. Various constructions are given. (NPO)

42487 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Atomic Energy of Canada Ltd.). French Patent 1,447,553. Filed Aug. 27, 1965.

A fuel element is described comprising a sheath consisting of a corrosion resistant Zr-alloy (e.g., Zircaloy-2), a fuel core consisting of metallic U containing 200 to 500 ppM Fe and 500 to 1200 ppM Al, provided with an axial channel, and an intermediate layer between the sheath and the core consisting of a corrosion resistant U-alloy containing 30 to 60% Zr, or 1 to 25% Mo or Nb, or 50 to 95% Al. The free space of the axial channel amounts to 5 to 15% of the total volume of the element and the volume of the intermediate layer amounts to 15 to 30% of the volume of the core. (NPO)

42488 FUEL ELEMENT FOR NUCLEAR REACTOR. (to EURATOM. Societa Generale per l'Industria Mineraria e Chimica). French Patent 1,445,884. Filed Aug. 12, 1965.

A fuel element which comprises a cylindrical container and a bar or pellets of fissile material is described. The fuel is spaced from the wall of the container by a layer which consists of a material having a high thermal conductivity and a low neutron absorption and which is liquid at the operating temperature. Preferably the material is disposed within the meshes of a cylindrical wire-gauze which contacts the fuel and the container. If the container consists of fritted Al-Al_2O_3, the gauze is preferably composed of Al-wire, the meshes being filled with metallic Pb. (NPO)

42489 METHOD FOR MANUFACTURING A NUCLEAR FUEL ELEMENT. (to Nuclear Developments Ltd.). French Patent 1,491,891. Filed Sept. 7, 1966.

A bar of U is coated by electrophoresis with Mg powder and then heated in an inert atmosphere (e.g., Ar) preferably containing a small dose of Br or UBr_4 to a temperature (e.g., 650 to 700°C) at which the Mg reduces the oxide film on the surface of the bar and is deposited as a coherent layer. (NPO)

42490 DESIGN AND FABRICATION OF IRRADIATION RIGS. Lehrheuer, W. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 321-5(June 1968). (In German and English).

The need for a clean area workshop for fabricating reactor rigs is stressed, and the conditions for clean assembly are listed. The need for a fully detailed assembly and testing schedule and checklist is stressed, and the main steps in the assembly of the relatively simple LV4 rig for spherical fuel elements are described. Mention is made of modular rig designs being developed. (auth)

42491 DESIGN OF HIGH TEMPERATURE FUEL RIGS. Stelzer, F. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 315-20(June 1968). (In German and English).

The analogy between Ohm's law in electricity and heat transfer phenomena is used for laying out fuel rigs, to get a circuit diagram The values of the heat resistances, appearing in the rig, can be found precisely by measuring. Desired temperatures in new rigs are accurately obtained. (auth)

42492 THE MEAN NEUTRON DENSITY IN INHOMOGENEOUS MEDIA. I. Stepanov, A. V. Kernenergie, 11: 125-31(May 1968). (In Russian).

The neutron transport in inhomogeneous media, which may be described by Boltzmann's equation with fluctuating parameters is considered. An approximate equation for the neutron flux averaged over the fluctuations in the medium is derived for the case of small-length fluctuations. The mean neutron flux is studied as a function of time and energy. Analytical expressions are given for the relaxation constants of the neutron distribution. A periodic reactor lattice is treated as an example of an inhomogeneous medium. (auth)

42493 SUMMARY OF TWO-GROUP CALCULATION FOR HETEROGENOUS URANIUM/WATER-SYSTEMS. PART II. Kovacs, Laszlo M. Energ. Atomtech., 21: 251-8(Apr. 1968). (In Hungarian).

Before the spread of electronic computers, the reactor physics calculations for heterogeneous uranium/water-systems were mostly carried out with the two-group diffusion method. The formulas for detailed calculation of the modified two-group diffusion method and the semi-empirical formulas of the two-group input parameters needed for concrete calculation are collected. The detailed theoretical deduction of the semi-empirical formulas is accompanied by a reference of literature sources. At the modified two-group diffusion approach the capture and the rise during the slowing down are taken into account and therefore the reactor physics calculations for uranium/water-systems corresponds very well with the measured results. (auth)

42494 SUMMARY OF TWO-GROUP CALCULATION FOR HETEROGENOUS URANIUM/WATER-SYSTEMS. PART I. Kovacs, Laszlo M. Energ. Atomtech., 21: 190-8(Mar. 1968). (In Hungarian).

Before the spread of electronic computers, the reactor physics calculations for heterogeneous uranium/water-systems were mostly carried out with the two-group diffusion method. The formulas for detailed calculation of the modified two-group diffusion method and the semi-empirical formulas of the two-group input parameters needed for concrete calculations are collected. The detailed theoretical deduction of the semi-empirical formulas is accompanied by a reference of literature sources. At the modified two-group diffusion approach the capture and the rise during the retardation were taken into account and therefore the reactor physics calculations for uranium/water-systems correspond very well with the measured results. (auth)

42495 BORDERLINE PROBLEMS IN REACTOR KINETICS AND REACTOR STATICS. Vigassy, Jozsef. Energ. Atomtech., 20: 493-501(Oct. 1967). (In Hungarian).

The basic equations of reactor kinetics are shown within the range of the point reactor model. The bounds of point kinetics are shown. The time-dependent transport equation is explained and more accurate definitions are given for ideas of the point kinetic mode. The connection of the time-dependent transport equation and the particular value problems in reactor measurements are shown. In the appendix the delayed neutrons and photoneutrons are described. 66 references. (auth)

42496 SPHERICAL FUEL ELEMENT FOR NUCLEAR REACTOR. (to Arbeitsgemeinschaft Versuchs-Reaktor GmbH). French Patent 1,468,137. Filed Feb. 12, 1966.

A fuel element is described which comprises a sphere of moderating material, containing fissile material. In order to increase the mechanical resistance of the element as well as the heat transfer from the centre of the element to its surface, the element is provided with a central bar, which extends from the filling-orifice to the opposite inner wall, leaving an annular fuel space. Various constructions are given. (NPO)

42497 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLY. (to Atomic Energy of Canada Ltd.). French Patent 1,439,634. Filed July 8, 1965.

A fuel assembly comprising a cluster of spaced elongate parallel sheathed fuel elements is described. The cluster is disposed in a rectangular or cylindrical container. The sheath of each element is provided on its outer surface with at least two longitudinally spaced groups of circumferentially spaced longitudinal projections which are adapted to engage slidably with similar projections on the sheaths of adjacent elements or with the inner wall of the container. An example is given in which the projections are cylindrically faced being convex outwards, the contact between co-operating projections being essentially line contact. In a modification the projections are flat on their mutually engaging faces. The contact is essentially surface contact. Preferably the projections are streamlined for flow of coolant past the projections in the longitudinal direction of the elements. (NPO)

42498 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,468,898. Filed Nov. 8, 1965.

A fuel assembly is described, comprising multiple parallel canned fuel rods consisting of a fissile ceramic material dispersed in a matrix of non-fissile ceramic material. The cans have a circular or hexagonal cross-section and contact one another lengthwise so as to form a total cross-section of honeycomb pattern, immobilizing the fuel rods against lateral movement. Coolant channels are provided by omitting a number of the rods, preferably being situated in a regular pattern, in such a way that immobilization is maintained. (NPO)

42499 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,362,995. Filed July 12, 1963.

A fuel element is described which comprises a column of straight cylindrical fuel pellets enclosed in a thin-walled tubular metallic sheath, the ends of which are closed by end caps welded into the ends of the sheath. In order to protect these welds from deformation due to different thermal contraction of the pellets and the sheath if the element drops in temperature, a load bearing pellet is provided in frictional engagement with the sheath between each end of the column of fuel pellets and the end caps. Generally the load bearing pellet is composed of sintered Al_2O_3. In the case of a Be-sheathed element a Be cylinder is preferably used. (NPO)

42500 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLY. (to Atomic Energy of Canada Ltd.). French Patent 1,459,031. Filed Aug. 17, 1965.

A fuel assembly is described comprising a cluster of spaced elongate parallel sheathed fuel elements which are annularly disposed one or more rings concentrically surrounding an inner element. The sheath of each element is provided on its outer surface with at least two longitudinally spaced groups of circumferentially spaced longitudinal projections which are adapted to engage slidably with similar projections on the sheaths of adjacent elements. Preferably the projections are cylindrically faced being convex outwards, the contact between co-operating projections being essentially line contact. (NPO)

42501 METHOD OF FABRICATION OF NUCLEAR FUEL ELEMENTS. (to Commissariat a l'Energie Atomique). French Patent 1,449,916. Filed July 9, 1965.

The fabrication of a fuel element usually consists in inserting a rod of fuel material into a can, in securing end-caps to the can by welding after degassing the element, and finally, in bringing the can into tight contact with the fuel material by application of a high external pressure. Usually the end-caps are provided with recesses intended to accommodate components for centering the element with respect to adjacent elements. Deformation of the end-caps during the canning operation and during welding is prevented by plugging the recesses with temporary plugging units, being formed of a material having a coefficient of thermal expansion which is equal or very close to that of the end-caps. (NPO)

42502 FUEL ELEMENTS FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,278,415. Filed Jan. 20, 1961.

A fuel element comprising a sheathed fuel member of elongate form is described. The ends of the sheath are sealed by end caps. In order to prevent stressing and consequent leakage of the seals caused by growth of the fuel due to the trapping of fission products in the fuel under irradiation, the fuel member is shaped in such a manner that its ends define end-growth-accommodating voids with adjacent parts of the element. The end caps are maintained in load-transmitting relation with the fuel member. Three different constructions are given. (NPO)

42503 METHOD FOR MAKING A COMPARTMENTED FUEL ELEMENT FOR A NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,222,922. Filed Mar. 20, 1959.

A method for making a fuel element is described which consists of coating the inside surface of an elongate cladding tube with a brazing alloy, inserting multiple fuel pellets and spacing members into the tube, the members being spaced at intervals between the pellets, and heating the element to a temperature sufficient to cause the fuel pellets to move the spacing members along the tube to positions sufficient for expansional space for the pellets during the use of the element and to braze the spacing members to the adjacent inner surface of the tube. Preferably the fuel consists of UO_2, the tube of a Zr-alloy, the spacing members of stainless steel and the brazing alloy of Ni–Fe–Cr-alloy. (NPO)

42504 END SYSTEM FOR FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,378,259. Filed Sept. 27, 1963.

Fuel elements suitable to be stacked in the coolant channel of the reactor and provided with hollow cup-shaped end-plugs are described. The rim of each plug is conterminous with the edge of the sheath of the element and welded thereto. Within the plug a cylindrical end piece is fitted, projecting from the plug and having an outer end face which is convex or concave in form, e.g., hemispherical or conical, and which, when the element is in operative position is in contact with the bearing face of matching form of the adjacent element. Preferably the plug is made of magnesium or magnesium alloy and the end piece of Zircaloy or graphite. Two different methods for fitting the end piece within the plug are given. (NPO)

42505 FUEL ASSEMBLY STRING FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,384,898. Filed Dec. 9, 1963.

A fuel assembly string is described comprising end stacked fuel assemblies which are made up of clusters of elongate sheathed fuel elements. The assemblies are threaded together into a spine for lifting and lowering of the string as a unit. The spine comprises a series of outer tubular members and one or more withdrawable locking means within the members. The members are linked together by releasable coupling means and secured in the coupled position by the locking means so that on withdrawal of the locking means the assemblies forming the string may be separated. Various constructions are given. (NPO)

42506 IMPROVEMENT IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,413,936. Filed July 30, 1964.

A fuel element is described in which the sheath is provided with integral longitudinal stiffening lugs which project radially from the sheath and are arranged in groups along the length of the sheath. The lugs in each group are spaced at equal intervals around the circumference of the sheath. The improvement consists in the provision of the group of lugs at one end of the sheath with means (e.g., indents of concave contour) for engagement by a fuel element lifting grab. (NPO)

42507 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,281,808. Filed Mar. 1, 1961.

An elongate fuel element is described for use in a column of similar elements. The elements are stacked in a vertical coolant channel of nuclear reactor. In order to prevent vibration of the elements when subjected to coolant flow, both ends of each element are provided with inclined or curved surfaces in such a way that relative lateral displacement of adjacent elements will take place causing contact of a part of the elements with the wall of the coolant channel. Various constructions are given. (NPO)

42508 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,281,810. Filed Mar. 1, 1961.

In order to prevent vibration of fuel elements which are stacked in a vertical coolant channel of a nuclear reactor, each element is provided with members which cause lateral displacement of the element under the influence of the coolant flow in such a way that the members contact the wall of the coolant channel. Preferably the members have four radially extending longitudinal baffles which are angularly spaced equally round the circumference of the element. The outer edges of the baffles are slightly inclined with respect to the longitudinal axis of the element. Various constructions are given. (NPO)

42509 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,439,488. Filed June 24, 1965.

A fuel element is described comprising a number of fuel discs stacked in a tubular sheath, a coiled spring for consolidation of the stack inserted between the upper disc and the upper end of the element which is closed by an end cap welded to the sheath. In order to protect this weld from damage the spring is not supported as by the end cap but by the sheath. The upper coils of the spring have an enlarged diameter and are in fictional contact with the sheath. (NPO)

42510 CLOSURE FOR TUBULAR FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,423,629. Filed May 28, 1963.

Thin vaulted wafers obturating the fuel in tubular fuel elements are described. The wafers have an annular base corresponding with the annular cross section of the fuel. The vaulted inner surface of the wafers which terminates the channel of the element has a spherical or a truncated conical shape. (NPO)

42511 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,448,501. Filed Sept. 28, 1965.

A fuel assembly is described comprising a cluster of spaced elongate parallel sheathed fuel rods, end supports for the rods, and at least one transverse bracing grid disposed intermediate the ends of the fuel rods for spacing the rods. The outer surface of each of the rods is provided with a group of spaced longitudinal projections coinciding with the grid(s) and adapted to engage slidably with and to space the rids from the grid(s). The projections are integrally formed with the sheaths of the fuel elements or are attached to their outer surface by brazing. (NPO)

42512 FUEL ELEMENT FOR NUCLEAR REACTOR. (to English Electric Co., Ltd.). French Patent 1,371,595. Filed Oct. 14, 1963.

A fuel element is described which is arranged to be supported axially between two further elements, having at one end a conical axially extending projection and at the other end a conical recess for engagement with similar members. Preferably the recess has a carbon mating surface, and the projection has a stainless steel mating surface. In a modification a stainless steel conical cap is put between the two mating members. This cap is attached to the conical mating member by setting or hammering. (NPO)

42513 METHOD OF ASSEMBLING FUEL RODS FOR A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,334,361. Filed May 30, 1962.

A method of assembling nuclear fuel rods comprising fuel pellets contained in sheaths and extending over the whole height of the reactor core is described. The rods are disposed in four square lattice sub-assemblies each having, at multiple levels, locating means composed of flat spacers between the rods and multiple bands surrounding the sub-assembly. The rods are secured axially solely at their lower portions to a support member. An example is given according to which the locating means comprise at each of the levels two superimposed pairs of bands consisting of two welded metal strips each surrounding half a sub-assembly and each pair defining two rectangles joined by one of their long sides to form a central divider. An elongate aperture is provided in the divider and the divider of one pair being perpendicular to the divider of the other pair. Also, two superimposed sets of flat spacers at the levels of the two pairs of bands are described each set of spacers comprising multiple parallel rectangular spacers one at each level. Each set is provided in the

middle of each of its long sides with a slot which cooperates with the margins of the elongated aperture in the divider at that level. The spacers in each set are perpendicular to the divider at that level and hence to the spacers at the adjacent level. (NPO)

42514 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Obertelli, John David; Campbell, Ronald Hugh; Holmes, John Arthur Godfrey; Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). U. S. Patent 3,393,128. July 16, 1968. Priority date Aug. 23, 1965, Great Britain.

A nuclear reactor fuel element assembly for use in water/steam coolant is described. A cluster of fuel rod elements is provided with cellular bracing grids which have deflectors for extracting water entrained in steam flow and directing it on to the fuel rods. (Offic. Gaz.)

42515 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,178,363. Filed July 10, 1957.

Described is an elongate fuel element for a fast nuclear reactor, in which several elements are arranged side by side. The outer wall of each element is provided with a series of bands of helical cooling fins, the fins of adjacent elements contacting each other. Optimum conditions are realized with four bands, each band comprising six fins, the inner two bands being close together with one on either side of the middle of the element, and the outer two bands being positioned near each end of the element, well separated from the inner two. (NPO)

42516 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Societe Rateau S. A.). French Patent 1,166,835. Filed Feb. 4, 1957.

In order to ensure correct positioning of an elongate fuel element in the coolant channel of the reactor the element is provided with oblique, plane, or curved surfaces at its ends, which surfaces abut against similar surfaces of adjacent elements and, under the action of an axial force, generate forces having a radial component, causing points of the element to abut the wall of the coolant channel. (NPO)

42517 FUEL ELEMENT FOR NUCLEAR REACTOR. (to C. A. Parsons and Co., Ltd.). French Patent 1,181,132. Filed Aug. 1957.

The container of the element is provided on its outside with helical cooling fins. The flow channels between the fins are interrupted by a number of longitudinal baffles, angularly spaced apart from each other over the periphery of the container and extending in a radial direction nearly to the wall of the coolant channel. The clearance between the edges of the baffles and the wall of the channel is dimensioned in such a way, that when the reactor is operating and the temperature rises, the clearance is taken up by the expansion of the baffles, their edges contacting the wall of the channel. In this way bending of the element is prevented. (NPO)

42518 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,156,074. Filed Aug. 22, 1956.

Described is a fuel element suitable for use as one of a column of elements stacked in a vertical coolant channel of a nuclear reactor, each element being individually supported by a member carrying the weight of the element. Preferably the member comprises a spider with pivoted legs, spring-loaded in a direction to move the legs outwardly so as to engage a supporting ledge provided in the wall of the coolant channel. (NPO)

42519 FUEL ELEMENT FOR NUCLEAR REACTOR. (to EURATOM). French Patent 1,463,321. Filed Jan. 8, 1966.

Described is a fuel element, comprising a fuel rod, which is provided with straight or curved narrow channels running the length of the rod and which, in cross section, extend from the center of the rod to its periphery. In this way radial expansion of the rod caused by growth of the fuel due to the trapping of fission products in the fuel under irradiation is almost entirely eliminated, thus preventing the generation of dangerous stresses in the sheath. (NPO)

42520 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,480,400. Filed Apr. 1, 1966.

Described is a fuel element comprising a metallic sheath sealed by end caps, a tube of fissile material, and a central strengthening bar, the fuel being in close contact with the sheath and the bar. Each end of the bar extends beyond the fuel and is enclosed in a protruding part of the end cap, which on its outside is provided with a male or a female member allowing several elements to be stacked in a column. (NPO)

42521 NUCLEAR REACTOR FUEL ELEMENT. (to Babcock and Wilcox Ltd.). French Patent 1,156,132. Filed Aug. 27, 1956.

A fuel element is described including a fuel bar enclosed in a sheath, wherein the cross-sectional dimensions of the bar and the sheath are such that the sheath is only partially filled, spacing means such as bosses, ribs, or distance rings being provided in order to prevent contact between the bar and the wall of the sheath. Various constructions are given. (NPO)

42522 DEVICE FOR ALIGNING FUEL ELEMENTS IN A NUCLEAR REACTOR CHANNEL. (to Commissariat a l'Energie Atomique). French Patent 1,327,261. Filed Apr. 6, 1962.

Described is a device for coaxially aligning fuel elements with one another when they are stacked in the coolant channel of a nuclear reactor, the opposed ends of two successive elements comprising respectively a male and a female portion which are secured to the end-plugs. The male portion consists of a ring surrounding a bearing face of the plug and having a semitoroidal outer surface, and the female portion consists of a ring surrounding the bearing surface of the outer plug and having a frustroconical internal surface. (NPO)

42523 MEANS FOR SUPPORTING A FUEL ELEMENT IN A VERTICAL COOLANT CHANNEL OF A NUCLEAR REACTOR. (to Electricite de France). French Patent 1,173,868. Filed Apr. 30, 1957.

Described is a means for locking against downward movement and for releasing a fuel element support slidably disposed in a vertical coolant channel of a nuclear reactor. At least two angled arms are pivotally secured to the support and arranged for engagement with at least two adjacent axially spaced notches provided in the wall of the channel. Two different constructions are given, in one of which the notches are provided in the form of two adjacent transversal grooves, in the other in the form of teeth located within two longitudinal grooves. (NPO)

42524 FUEL ELEMENT FOR NUCLEAR REACTOR. (to English Electric Co., Ltd.). French Patent 1,428,675. Filed Mar. 8, 1965.

Described is a fuel element which is constituted by a fuel rod encased in a container which is closed at both ends by means of a metallic plug, a thermally insulating disc being positioned between the plug and the fuel rod. In order to stop the normal creep of the metal of the plug at the temperatures and under the loads to which the plug is subjected during the operation of the reactor, an annulus tightly encircling at least a part of the plug is provided between the plug and the wall of the container, said annulus consisting of a material which is more resistant to creep than the material of the plug. (NPO)

42525 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,473,062. Filed Dec. 22, 1965.

A sheathed tubular fuel element is described which comprises two coaxial tubes of fissile material separated by a layer which consists of a material having a low heat conductivity. Various constructions are given. (NPO)

42526 A NUCLEAR FUEL ASSEMBLY, AND A METAL GRID FOR SAME. (to Licentia Patent-Verwaltungs GmbH). British Patent 1,122,189. July 31, 1968. Priority date Dec. 7, 1964, Germany.

A fuel element assembly containing a wire lattice structure spacing grid is described. The grid is formed of mutually crossing wire members formed with bends of which the peaks lie at the edges of the fuel rod spaces. The peaks of the wire members engage the side walls of the fuel rods and support the rods at regular spaced intervals. (H.D.R.)

42527 MACHINE FOR TAPPING GAS PRESENT IN A CLOSED ENVELOPE OR FOR PRESSURISING SUCH AN ENVELOPE. Hespel, Claude (to EURATOM). British Patent 1,122,088. July 31, 1968. Priority date June 14, 1965, Belgium.

An apparatus for use in tapping a fuel element for fission gas sampling is described. The device includes a means for clamping to the fuel can, a hollow piercing needle with a lateral opening, a deformable sealing sleeve around the needle and covering the opening, and a capsule connected to the needle for collecting the fission gas. The device can also be used for introducing gas into a sealed envelope or enclosure. (H.D.R.)

42528 METHOD OF DETERMINING MAXIMUM TEMPERATURES IN THERMAL TREATMENT DEVICES. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,121,744. July 31, 1968. Priority date Jan. 21, 1966, Germany.

A method of determining the maximum temperature of specimens irradiated in reactors by employing magnetized ferro-

magnetic transducers is described. The transducers are calibrated as a function of temperature, introduced into the sample to be irradiated, and the change in magnetic field strength is measured after irradiation. (H.D.R.)

42529 NUCLEAR FUEL ROD ASSEMBLY. (to United States Atomic Energy Commission). British Patent 1,121,562. July 31, 1968. Priority date June 16, 1965, United States.

A reactor fuel element assembly structure is described which provides a means for separating and positioning individual fuel rods without fastening the spacer to the rods or employing spring-action spacer construction. The assembly structure consists of a cylindrical sleeve scalloped to form curved channels for the exterior fuel rods. The spacer devices consist of metal strips bent to form equilateral triangles with rounded corners. The spacers are held in position in the assembly sleeve by inward projections above and below the spacer tips. The completed assembly consists of a central rod and 6 outer rods arranged in a regular hexagonal pattern and held in position by a pair of spacer devices. (H.D.R.)

42530 NUCLEAR FUEL ASSEMBLY. (to Westinghouse Electric Corp.). French Patent 1,417,143. Filed July 19, 1964.

A fuel assembly is described comprising an elongate casing, multiple bundles of fuel rods tandemly and slidably mounted within the casing, and structural means consisting of a material having a greater coefficient of thermal expansion than the fuel bundles and joining the bundles so that the bundles are longitudinally displaced from each other. The structural means may comprise an elongate support member having a high coefficient of thermal expansion and coextending with substantially the total combined length of the fuel bundles. Al least two of the bundles are joined at their opposite outwardly disposed end portions to the support member and disposed so that the remaining portions of the bundles are mounted for movement relative to the adjacent portions of the support member. At least a portion of the support member may comprise a fissile material. Various constructions are given. (NPO)

42531 FUEL ASSEMBLY FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,422,213. Filed Nov. 5, 1964.

A fuel assembly is described comprising multiple parallel canned fuel pencils enclosed within a protective jacket, the cans abutting one another and peripheral cans abutting the inner wall of the jacket to maintain the parallel relation of the pencils, a grid provided adjacent one end of the cans to restrain the cans against axial movement, and ducts of circular cross section between the cans for the flow of a coolant. The ducts are formed by parts of the outer contours of adjacent cans. Preferably each can has a polygonal profile in cross section, some of the sides of the polygon being concave. The outer parts of the cans which define the coolant ducts may be provided with a helical groove for imparting a gyratory movement to the flow of coolant. (NPO)

42532 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,461,662. Filed Oct. 28, 1965.

A fuel element is described comprising a sheathed stack of U-graphite fuel pellets, and thin metal discs (e.g., Mg) being interposed between the pellets. The discs have a diameter which is slightly smaller than the diameter of the pellets. In this way narrow annular grooves are formed into which the surrounding part of the sheath is pressed. Longitudinal stiffening lugs extend laterally from the outer wall of the sheath. Preferably the element is surrounded by a cylindrical supporting jacket of graphite, the element being centered in the jacket by metallic wires connecting the end caps of the sheath with the ends of the jacket. (NPO)

42533 STOCHASTIC FORMULATION OF NEUTRON MULTIPLE COLLISION PROCESSES BY THE FIRST-COLLISION PROBABILITY METHOD. Saito, Keiichi; Taji, Yukichi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 5: 315-17(June 1968).

A fundamental recurrence relation concerning the multiple collision method for describing the slowing down processes of neutrons in fast reactors and for analyzing neutron transport by Monte Carlo technique is derived. (D.C.C.)

42534 GAMMA-RAYS AND FAST NEUTRONS STREAMING ABOUT AN ANNULAR DUCT. Kitazume, Mitsuyuki (Central Research Lab., Hitachi, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 279-86(June 1968).

Leakage radiation from an infinite plane source reaching the rear surface of a shield provided with an annular duct is evaluated numerically. The plane of the infinite source is divided into eight zones, for the convenience of integration, and the contribution of each zone is calculated separately by ray analysis. The distribution of the radiation flux and dose rate around the duct are systematically obtained for different shielding materials and source energies, and the effect of changing duct geometry is also analyzed. The predominant portion is provided by zones outside the annular area, and this predominance extends even to the region of shield surface directly above the duct. It is also demonstrated that Rockwell's expression based on Line-of-Sight method is included as a special case of the present formula, which is applicable not only to γ-rays, but also to fast neutrons. (auth)

42535 NUCLEAR REACTOR. (to Hawker Siddeley Nuclear Power Co., Ltd.). French Patent 1,215,447. Filed Mar. 17, 1960. Addition 77,373.

A nuclear reactor is described in which is included, preferably within a fuel element, a body of low surface to mass ratio which is composed of a material having a high thermal neutron absorption and a material which upon elevation of the fuel temperature to a predetermined danger value will undergo a change of state and thereby increase the surface to mass ratio of the body to cause increased neutron absorption and a consequent reduction in the reactivity of the reactor. (NPO)

42536 NUCLEAR FUEL ASSEMBLY END FITTING. (to EURATOM). French Patent 1,438,871. Filed July 1, 1965.

A fuel assembly end fitting which, for renewal of the fuel, can be separated from the casing by remote control is described. The lower border of the end fitting is provided with cavities, housing a number of locking members, preferably spring-actuated push-buttons, which extend radially into corresponding perforations of the surrounding upper rim of the casing. In order to release the locking members their extending parts are pushed back by means of remote controlled levers. (NPO)

42537 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,160,035. Filed Oct. 16, 1956.

A fuel element is described which comprises a fissile fuel member, sheathed in a protective can, and suitable to be stacked in a column with other similar elements. Between each end of the fuel member and the ends of the can a non-fissile member is interposed, consisting of a material which has a high compressive creep strength and low neutron absorption, while the parts of the can embracing the non-fissile members have extended heat transfer surfaces whereby under operating conditions the temperature of the parts of the can which are stressed by the weight of the fuel member is less than that of the parts not so stressed. (NPO)

42538 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to EURATOM). French Patent 1,408,038. Filed Sept. 17, 1964.

A fuel element assembly for a nuclear reactor is described comprising multiple sheathed fuel pencils which are disposed in parallel relation in a vertical reactor channel which is constituted by a calendered tube immersed in a moderator mass. Each pencil is surrounded by an individual pressure tube running the length of the reactor core. The coolant flows under pressure through the pressure tubes. The space between the tubes and the calendered tube is filled with a thermal insulating fluid such as nitrogen. (NPO)

42539 SUPPORT HOUSING FOR NUCLEAR FUEL ASSEMBLIES. (to Commissariat a l'Energie Atomique). French Patent 1,228,914. Filed Mar. 16, 1959.

A support housing for nuclear fuel assemblies is described comprising a cylindrical body of low neutron absorption. The housing includes multiple compartments distributed regularly in the body parallel to the body axis and extending from end-to-end of the body. Each compartment forms a receptacle which may receive a fuel rod of substantially the dimensions of the compartment and support the rod over its length and center it relative to the compartment. The abutments form releasable retaining means for the rods. Preferably the cylindrical body is a graphite block in which longitudinal channels are drilled to form the compartments. Various constructions are given. (NPO)

42540 NUCLEAR REACTOR. (to Beteiligungs- und Patentverwaltungsgesellschaft mit Beschraenkter Haftung). French Patent 1,336,626. Filed Oct. 22, 1962.

A nuclear reactor is described which includes horizontally disposed fuel rods arranged one above another to form a ladder-like structure, the elements forming the rungs of the ladder. In a modification the uprights of the ladder are hollow and the elements are hollow cylinders which communicate with the uprights, one of the latter constituting an inlet and the other an exhaust tube for the coolant-moderator. Preferably one of the uprights is adapted for movement in the direction of the axes of the fuel

elements so that it can yield to the thermal expansion of the elements when raised to the operating temperature. Various constructions are given. (NPO)

42541 CLUSTER FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,322,485. Filed Apr. 24, 1962.

A cluster fuel element is described comprising a spaced array of individual fuel members end-located by a pair of grids constructed from thin section strips. The ends of the fuel members are united with the grids in a manner to prevent relative movement between the members and the grids, the latter being deformable by individual changes in the longitudinal dimensions of the fuel members. At least one of the grids has its thin section strips troughed transversely at intervals and assembled with the lengths of the strips intermediate the troughs juxtaposed in pairs to form webs of double thickness with the troughs coming together to define openings for the ends of the fuel members. The juxtaposed lengths of the strips are secured together remotely from the openings. (NPO)

42542 CLUSTER FUEL ELEMENT FOR NUCLEAR REACTOR. (to EURATOM). French Patent 1,347,499. Filed Feb. 15, 1963.

A cluster fuel element is described comprising a matrix which is made of a material having a low neutron absorption coefficient and which is provided with elongate sub-channels for the reception of the fuel pencils. The matrix is formed of blocks disposed side-by-side and having adjacent faces lying in planes which are parallel to the axes of the subchannels and intersect these channels. Resilient means are provided for pressing the blocks against one another. Preferably the blocks are identical and their cross-sections have the shape of a circular sector, whereby the blocks may be assembled to form a cylinder, the resilient means consisting of metallic rings surrounding the matrix. (NPO)

42543 TRANSDUCER FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,446,982. Filed Sept. 16, 1965.

A transducer is described which comprises a chamber containing a liquid and a material intended for the development of heat during the operation of the reactor. The liquid and the material are arranged in such a way that an identifiable acoustical signal is produced in case the heat-transmission from the material to the liquid is changed due to variations of the temperature, the pressure or the power of the reactor. The sound waves may be produced by a whistle blown by the vapour of the boiling liquid or by the singing caused by the formation of bubbles in the liquid. Various constructions are given. (NPO)

42544 FUEL ELEMENT FOR NUCLEAR REACTOR. (to EURATOM). French Patent 1,446,540. Filed Aug. 9, 1965.

A fuel element comprising a core of fissile material surrounded by a thin-walled (e.g., 0.05 to 0.1 mm) cylindrical container preferably of stainless steel is described. The space between the core and the wall of the container is filled with a material having low neutron absorption characteristics and a high heat-conductivity (e.g., a Mg–Zr-alloy). The wall of the container is corrugated in such a way as to form on its inner side numerous narrow-longitudinal grooves serving as cooling fins and at least three wide longitudinal grooves angularly spaced apart from each other over the periphery of the container and extending nearly to the wall of the coolant channel of the reactor to serve as centering members. In order to strengthen the structure the cavity within the grooves is filled by a rigid longitudinal rod (e.g., of Zr or Be) contacting the fissile material. In a modification the bar is replaced by a slender cylinder of stainless steel filled with strongly compressed MgO-powder. (NPO)

42545 FUEL ELEMENT FOR A GAS-COOLED NUCLEAR REACTOR. (to Central-Electricity Generating Board). French Patent 1,480,704. Filed May 20, 1966.

A fuel element is described which comprises U-metal or U-base alloy fuel sheathed with an externally finned can. The can is formed of composite material with the inner portion of a ductile material (e.g., Magnox Al 80 or Magnox ZR 55) and the outer portion, including at least the fins, of a material of higher creep resistance than the inner portion (e.g. Magnox Zr 57, Magnox MN 70 or Magnox MN 150) preferably Magnox CP ZR 55, Magnox CP ZR 57 or Magnox CP Al 80. If the inner portion is formed of Magnox ZR 55 a graphite interlayer is provided between the can and the fuel to restrict Pu diffusion. (NPO)

42546 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Nuclear Energy Co. Ltd.). French Patent 1,339,749. Filed Oct. 30, 1962.

A fuel element which comprises an oxidizable fuel located in a closed container is described. In order to detect at the earliest possible moment any small leaks in the container so as to be able to remove the faulty element before significant oxidation of the fuel occurs, the container is also provided with material (e.g., Zr, alloyed with small amounts of Ti or Al) which is more readily oxidizable than the fuel. When oxidized due to leakage of coolant into the container a volume change is produced sufficient to produce a detectable leak in the container. Various constructions are given. (NPO)

42547 FUEL ELEMENT FOR NUCLEAR REACTOR AND METHOD FOR ITS MANUFACTURE. (to International Research and Development Co. Ltd.). French Patent 1,441,943. Filed July 19, 1965.

A fuel element is described which comprises a fuel bar disposed in a container. The bar is spaced from the container by a thermally conducting layer of compacted powdered material (e.g., a mixture of Mg and Be powders containing 0.6% of Be). In the manufacture the powdered material is compacted by forces applied to the outside of the container, e.g., by mechanical swaging or by the detonation of an explosive material. (NPO)

42548 METHOD FOR MANUFACTURING A FUEL ELEMENT FOR NUCLEAR REACTORS. (to EURATOM). French Patent 1,465,890. Filed Jan. 26, 1966.

A method for manufacturing a fuel element which consists of a fissile carbide sheathed with a metallic can is described. After filling the can with fuel pellets an oxidizing agent in liquid or gaseous form (e.g., hot air) is introduced into the can which causes a superficial oxidation of the fuel and in consequence an expansion of the pellets. A closer contact between the fuel and the can results. Improved heat transfer from the fuel to the coolant is achieved. (NPO)

42549 CLUSTER FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,339,615. Filed Aug. 16, 1962.

A cluster fuel element is described in which the different fuel pencils are held in a definite geometrical arrangement by an attachment grid to which one of their ends is fixed. The other end is left free to slide in a second grid. Free spaces are provided in the pencils for the expansion of the fission gases. The spaces are interconnected via minute channels made in the attachment grid. In order to increase the expansion volume the assembly of the free spaces in the pencils and the grid is connected to additional free spaces made in rigid structural elements connecting the two grids, e.g., non-fissile central pencils, an outer jacket and/or tie-rods. Preferably the attachment grid is constituted by two parts of which one carries the minute channels, the two parts being assembled by brazing. (NPO)

42550 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to Babcock and Wilcox Co.). French Patent 1,255,816. Filed Apr. 30, 1960.

A fuel rod bundle is described in which means is provided for locating the rods relatively to each other and spacers are provided to connect each of the outer rods to an adjacent outer rod. The spacers are located intermediate of the ends and project outwardly. The spacers are annular members the axis of which extend lengthwise of the rods. Various constructions are given. (NPO)

42551 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to Babcock and Wilcox Co.). French Patent 1,254,336. Filed Apr. 16, 1960.

A fuel element assembly containing a bundle of fuel rods extending lengthwise of the assembly is described. The content of fissionable material in the outermost rods of the bundle is less than the average content of fissionable material in all the rods of the bundle. If the bundle is of rectangular or polygonal cross-section and is surrounded by a sleeve, the ratio of fertile to fissionable material in the center portions of the rods that are situated in the angles of the sleeve is less than other portions of these rods. The rods may have the form of tubes which contain fuel pellets and are closed by end caps. Spacers are interposed between the pellets and the caps, each spacer having two end portions of substantially the same cross-section as the pellets, which portions are connected together by a stem of smaller cross-section. (NPO)

42552 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Siemens-Schuckertwerke Aktiengesellschaft). French Patent 1,229,381. Filed July 6, 1959.

The patent relates to a fuel element comprising one or more shaped bodies (e.g., solid or hollow rods or plates) consisting of heat-resistant, high-melting point fissionable material disposed within a longitudinally extending container. Each shaped body is

supported out of contact with the container by one or more holders made from graphite or a ceramic material, which are fixed to the wall of the container by one or more metallic centering members. Preferably the shaped bodies consist of a Zr–U-alloy, a cermet or a mixture of enriched U- or Pu-carbide with graphite. (NPO)

42553 FUEL ELEMENT FOR NUCLEAR REACTOR AND METHOD FOR ITS MANUFACTURE. (to Commissariat a l'Energie Atomique). French Patent 1,479,289. Filed Feb. 2, 1966.

A fuel element is described which comprises a ceramic nuclear fuel (e.g., UO_2) sheathed with a can of Zr of Zr-alloy, a layer which consists of the nitride of a metal, preferably Ti-nitride, being interposed between the fuel and the can. The intermediate nitride layer is produced by coating fuel pellets with the metal or a suitable compound (e.g., TiO_2) by means of a spraying gun and then heating the coated pellets to a temperature of 1000 to 1500°C in an atmosphere containing 60 vol % of N_2 and 40 vol % of H_2. In a modification the pellets are heated to 1300 to 1700°C in order to sinter the fuel particles simultaneously with the production of the nitride. (NPO)

42554 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,429,947. Filed Apr. 14, 1965.

A fuel element is described comprising a ceramic fuel of relatively low fissionable content having an axial void therein (e.g., sintered pellets of natural UO_2) a tube of a corrosion-resistant material (e.g., Zircaloy-2) surrounding the fuel, and a slender wire of metallic fuel of relatively high fissionable content (e.g., Pu–Zr-alloy) disposed in the axial void. This void is sufficiently large to accommodate the reaction products formed when the wire oxidizes on being used in the reactor and sufficiently narrow to prevent them from collapsing towards the bottom. Preferably the volume of the void is about $2\frac{1}{2}$ times the volume of the wire. The element is regenerated by replacing the wire. (NPO)

42555 METHOD OF CLOSING ENDS OF PROTECTIVE TUBES FOR NUCLEAR REACTOR FUEL ELEMENTS. Coulter, Robert Smith; Oldfield, William (to United Kingdom Atomic Energy Authority). U. S. Patent 3,392,438. July 16, 1968. Priority date Apr. 7, 1964, Great Britain.

A method of closing the ends of protective tubes for nuclear reactor pin-type fuel elements is described. A tubular support member is located within an end of a protective tube so that a portion of the outer surface of the member engages the opposing inner surface of the protective tube. The tube is sealed by swaging an apertured neck in the region of the engaged surfaces, cutting through the neck, and then by welding the exposed aperture shut. (Offic. Gaz.)

42556 FUEL-MODERATOR ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,441,629. Filed Apr. 26, 1965.

A fuel-moderator element is described comprising a canned composite rod which is composed of UO_2 particles dispersed in a moderator matrix consisting of YH. In order to prevent the reduction of the UO_2 by the hydride the fuel particles are previously coated with a layer of a material which does not react with YH (e.g., Mo). The can which consists of Mo or a refractory alloy (e.g., Inconel or Hastelloy) is coated on its inner surface with an enamel layer consisting of $Al_2O_3 \cdot SiO_2$ and $ZrSiO_4$. Preferably a layer of Mo is interposed between the enamel-layer and the hydride. (NPO)

42557 GRADIENT FUEL PLATES FOR NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,305,662. Filed Oct. 5, 1961.

Fuel plates for reactors of the flux-trap design are described. The reactor consists of a central fissionable fuel bearing core surrounded by a protective cladding. In order to provide a fuel element having internal fuel and burnable poison concentration gradients simultaneously, the central core is constructed as a composite body comprising a primary core containing fissionable fuel (e.g., U_3O_8 or UO_2 dispersed in an Al matrix, or UO_2 or UC dispersed in a stainless steel matrix) and varying in thickness across its width, and a secondary core consisting of a burnable poison (e.g., B) dispersed in a carrier material (e.g., Al) covering at least one of the major surfaces of the primary core. In a modification the primary core contains a burnable poison in addition to the fissionable material. Various constructions are given. (NPO)

42558 APPROXIMATE SOLUTION TO SPACE DEPENDENT KINETICS PROBLEMS. Suda, Nobuhide (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 377-8(July 1968).

An approximation technique for solving space dependent kinetics problems is given. A synthesis technique is used for developing a one-group model in which the delayed neutron effect is ignored. The transient flux distribution in a uniform infinite slab core is determined; these results are compared with the exact solution. (M.L.S.)

42559 REACTOR PHYSICS. VOLS. 1 AND 2. Schulten, R.; Gueth, W. London, Harrap, 1967. 298p. 22s. 6d. Each Vol. Translated by W. K. Mansfield from German Text (1960).

The subject is treated under the following main headings: diffusion and slowing down theory; inhomogeneities of the reactor core; the heterogeneous reactor; two-group theory; kinetic behavior of a reactor; influence of temperature on reactor kinetics; poisoning of a reactor; problems in breeding and conversion; dependence of thermal properties of a reactor on neutron flux; vector analysis; Fourier series and integrals, cylinder and spherical functions; and operators and matrices. (UK)

42560 TESTING FOR FUEL ELEMENT SHEATHING FAILURES IN NUCLEAR REACTORS. Burton, Eric John; Cartwright, David Kendall; Evans, Paul Bernard Francis (to United Kingdom Atomic Energy Authority). U. S. Patent 3,393,126. July 16, 1968. Filed Nov. 7, 1966.

For the detection of fuel element sheathing failure in the core of a nuclear reactor a delayed neutron detector is mounted outside the reactor pressure vessel wall to scan a local region on the inner side of the wall through which region coolant from the core is constrained to flow. The detector is shielded from all radiation save that emitted from the region. The solid angle defining the field of view of the detector of the region is variable by means of filter members interposed between the detector and the vessel. (Offic. Gaz.)

42561 FUNDAMENTAL PROPERTIES OF THE COHERENCE FUNCTION IN SYMMETRICAL TWO-NODE SYSTEMS. Albrecht, R. W.; Seifritz, W. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 11: 143-8(1968).

The coherence function relating the stochastic functions of two nodes in coupled systems displays properties relating to the coupling between nodes. This coherence function is developed for a general, symmetrical, two node system and applied to a zero power nuclear reactor model. It is shown that the coherence function is always real in this case and that from its form one may deduce the subcriticality of one node in two different ways and the phase shift of the function describing the time delay between nodes is directly obtained from the lowest frequency zero of the coherence function. The subcriticality of the reactor may be found from measurements of the coherence function when the manner in which subcriticality is obtained from a system once critical is known. The general properties of coherence functions for this particular class of systems are derived and discussed. Equations which are appropriate to particular cases are tabulated. 11 references. (auth)

42562 ON THE BACKGROUND COUNTS IN THE ROSSI-α EXPERIMENT. Iijima, Tsutomu (Japan Atomic Energy Research Inst., Ibaraki, Japan). Nukleonik, 11: 157-9(1968).

The uncorrelated term in the Rossi-α method is usually considered to be equal to the counting rate. It is proposed that in the ordinary method using a multi-channel time analyzer the uncorrelated term must be time-dependent. Results of experiments are given by which the assumption was proved. (auth)

42563 TRANSDUCERS. Maidment, Leslie; Ledwidge, Thomas Joseph (to United Kingdom Atomic Energy Authority). British Patent 1,122,844. Aug. 7, 1968. Filed Sept. 21, 1964.

A description of an acoustic warning device for nuclear reactor heat variation is presented. The transducer consists of a contained liquid which boils at a certain raised temperature. The vapor from the boiling liquid is forced through an orifice to generate a whistle. The boiling liquid receives heat from a fusible link which melts at a warning temperature level and allows heat flow to the transducer liquid. (D.C.C.)

42564 PRESSURE VESSEL. Benzler, Hartwig (to EURATOM). British Patent 1,123,980. Aug. 14, 1968. Priority date Dec. 7, 1964, Germany.

A description is presented of a nuclear reactor pressure vessel which consists of an inner sealing skin supported by an outer structure. The outer structure is composed of multiple C-shaped members radiating from a common axis. The members are secured at their ends by polar caps on the axis. (D.C.C.)

42565 FUEL ELEMENT FOR NUCLEAR REACTORS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,123,996. Aug. 14, 1968. Priority date May 19, 1965, Germany.

A description of a nuclear reactor fuel element assembly is presented. The fuel assembly consists of multiple parallel fuel

rods located inside tubular inserts. The tubular inserts serve to align the fuel rods and to guide the coolant in a whirling flow over the fuel rods. (D.C.C.)

42566 LIQUID-COOLED NUCLEAR REACTOR. Stanners, Walter Forrester (to United Power Co., Ltd.). British Patent 1,122,841. Aug. 7, 1968. Filed Dec. 12, 1963.

A description of an emergency cooling and containment system for a liquid-cooled reactor is presented. The containment system consists of a gas-filled shock wave attenuating space. An outlet at the bottom of this space leads to a heat exchanger which returns coolant to the top of the reactor vessel. The reactor vessel is designed so that the base ruptures in response to internal shock waves. (D.C.C.)

42567 FLEXIBLE SPACER. (to Atomic Energy of Canada Ltd.). British Patent 1,122,728. Aug. 7, 1968. Priority date Dec. 31, 1965, Canada.

A description of a fuel rod spacer is presented. The spacer is designed for multiple metal-clad rod-type fuel elements. The spacers consist of hairpin-shaped, double crank-shaped, and quadruple crank-shaped wire. The spacers are attached to fuel rods by spot welding. (D.C.C.)

42568 IMPROVEMENTS RELATING TO GRABS FOR USE IN NUCLEAR REACTORS. Penniston, Roy Leonard; Sims, John; Maisey, Albert John (to Fairey Engineering Ltd.). British Patent 1,122,981. Aug. 7, 1968. Filed June 18, 1964.

A description of a grab device for a nuclear reactor loading machine is presented. The grab device consists of a ball latch for engaging the grabbed object, two relatively movable cooperating grab members for actuating the latch, and releasable locking means for locking the two grab members. The grab members consist of a pair of coaxial sleeves. This grab device is designed with a power-driven hoist for a cable-suspended fuel loading machine. (D.C.C.)

42569 DETECTION OF DEFECTS IN THE FUEL ASSEMBLIES OF NUCLEAR REACTORS. (to Allmaenna Svenska Elektriska Aktiebolaget). British Patent 1,122,850. Aug. 7, 1968. Priority date Dec. 16, 1964, Sweden.

A description of a detecting system for nuclear reactor fuel element failure is presented. The detecting system consists of a reactor loading machine fitted with multiple tubes which sample fuel assembly coolant flow. The tubes carry the coolant through a monitored region for inspection. (D.C.C.)

42570 Al–Al_2O STRUCTURES AND PROCESS FOR OBTAINING SAME. Gualandi, Dante; Jehenson, Pierre (to EURATOM). British Patent 1,123,394. Aug. 14, 1968. Priority date Mar. 30, 1965, Italy.

A description of the production process for sintered Al–Al_2O_3 is presented. Fabrication of tubular containers from sintered Al–Al_2O_3 is described. The production process consists of stages of pulverizing high purity aluminum and then grinding the powder in the presence of oxygen and a silicone as a grinding or lubricating agent for partial oxidation to Al_2O_3. Sintering and extrusion stages for completed tubes are performed. (D.C.C.)

42571 NUCLEAR REACTOR FUEL ELEMENTS. Campbell, Norman Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,123,557. Aug. 14, 1968. Filed Aug. 9, 1966.

A fabrication method for a nuclear reactor fuel element is described. The method consists of forming multiple clad plates around a cylindrical mandrel and longitudinally welding the plates together with an electron beam welding technique. (D.C.C.)

42572 A METHOD OF MANUFACTURING FUEL ELEMENTS. Smith, Samuel Spenceley; Hayfield, Peter Charles Steele (to Nuclear Developments Ltd.). British Patent 1,122,648. Aug. 7, 1968. Filed Sept. 7, 1965.

A manufacturing method for fuel elements is described. The method consists of electrophoretically depositing magnesium powder on the surface of a uranium rod. The rod is heated at 650 to 700°C to form a coherently coated rod. (D.C.C.)

GENERAL

42573 (AEC-tr-6810) NUKLEONIKA. Translation of Nukleonika, 12: 1-174(1967). 170p. (AEC-tr-6811). CFSTI.

42574 (NP-17485) NUMERISK INTEGRATION MED ADAPTIVA MONTE CARLO METODER. (Numerical Integration with Adaptive Monte Carolo Methods). Eriksson, Bo (Aktiebolaget Atomenergi, Studsvik (Sweden)). Jan. 3, 1968. 26p. (In Swedish). (RFN-301). Dep.

An adaptive Monte Carlo method is introduced. A numerical integration method which is applicable to the integration of positive strongly varying functions is introduced using the adaptive Monte Carlo method. (J.S.R.)

42575 (NYO-3477-12) MECHANISMS OF EROSION OF DUCTILE METALS BY SOLID IMPINGEMENT. Final Report. Moore, Mark B. (Rutgers-The State Univ., New Brunswick, N. J. Bureau of Engineering Research). Mar. 1968. Contract AT(30-1)-3477. 23p. Dep. CFSTI.

The rate of loss of material from an eroded ductile metal surface was found to be a function of the rate of energy transfer from the eroding particles to the surface, as well as a function of the angle of incidence of the particles upon the surface. Three separate phases or types of erosion were identified, and the mechanisms of each phase were studied and presented. The concentration of eroding particles in the carrier gas was found to have an effect upon the erosion rate, but particle velocity and particle size effects were quite small within the test limits. (auth)

42576 (NYO-3497-13) THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS. Progress Report, December 1, 1966-November 30, 1967. Taylor, W. Rowland; Carpenter, James H. (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Contract AT(30-1)-3497. 13p. Dep. CFSTI.

Sixteen species of unicellular algae were isolated and cultured from tropical surface waters of the Atlantic Ocean. The organisms were identified and described and studies on nutrition and physiology were conducted. A medium containing EDTA and several chelating metals was used for culturing marine algae. Equations were derived to describe the equilibria in the medium, and a computer model was constructed to describe the free ionic balance between EDTA and Mg, Ca, Co, Zn, and Fe ions. Studies on cultures of Cyclotella nana, Monochrysis lutheri, and Isochrysis galbana showed that growth rate was dependent on the vitamin B-12 concentration. Studies were conducted on the effects of light intensity on growth, pigment composition, carbon assimilation, and excretion in Isochrysis galbana. (H.L.W.)

42577 (ORNL-4264) LINEAR: A COMPUTER PROGRAM TO FIT DATA EASILY TO MANY MODELS BY THE WEIGHTED LINEAR LEAST-SQUARES METHOD. Schonfeld, E. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 24p. Dep. CFSTI.

LINEAR is a computer program, written in FORTRAN, that fits experimental data easily and rapidly to as many as 80 different models by the weighted linear least-squares method. The program permits the user to introduce his own model. Execution time on the CDC-1604 is about 1 min, and the cost is about $1.00 to $2.00. The program is written in such a way that it can be used with different computers and computer languages, such as FORTRAN II (IBM-7090), FORTRAN 62 (CDC-1604, -3600), FORTRAN 63 (CDC-1604, -3600), FORTRAN 360-ORNL (IBM-360), FORTRAN IV (IBM-7094/0), FORTRAN IV (IBM-360), FORTRAN IV (UNIVAC-1108), and FORTRAN ASA. (auth)

42578 (ORNL-4279) SPECTROPHOTOMETRY OF AQUEOUS HNO_3, H_2SO_4, AND $DClO_4$ FROM 25^0 TO 250^0C. Waggener, W. C.; Weinberger, A. J.; Stoughton, R. W. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Dilute nitric, sulfuric, and perchloric acids are applicable as solvents for spectrophotometry up to 250°C over the following ranges: 0 to 1.0 f HNO_3 from 0.6 to 1.2 μ; 0 to 0.2 f H_2SO_4 from 0.25 to 1.2 μ; and 0 to 1.0 f $DClO_4$ from 0.25 to 1.8 μ. Each of these acids reacts measurably with the titanium cell wall and the sapphire windows at rates which increase with acidity and temperature. This corrosion affects the spectral measurements as a function of time and is associated with deterioration of cell window surfaces and the presence in the sample of dissolved and suspended corrosion products. These results are part of our more general program for the development of equipment and technique for routine spectrophotometry of pure liquids and solutions over a wide range of temperature and pressure. (auth)

42579 (SC-RR-68-446) AN APPLICATION OF A COMPUTER PROGRAM FOR THE COMPUTATION OF FORCE AND MOMENT COEFFICIENTS ON ARBITRARILY SHAPED BODIES TO THE AGENA SPACE VEHICLE. Waggoner, C. N. (Sandia Corp., Albuquerque, N. Mex.). July 1968. 32p. Dep. CFSTI.

The input data deck used to compute the force and moment coefficients of the Agena space vehicle is described. The results obtained from the program are compared with two previous independent calculations. (auth)

42580 PUBLIC WORKS APPROPRIATIONS FOR 1969, FOR WATER AND POWER RESOURCES DEVELOPMENT, AND THE ATOMIC ENERGY COMMISSION. PART III. HEARINGS BEFORE A SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS HOUSE OF REPRESENTATIVES, NINETIETH CONGRESS, SECOND SESSION, SUBCOMMITTEE ON PUBLIC WORKS. Washington, D. C., Committee on Appropriations Subcommittee on Public Works, 1968. 731p. GPO.

Appendix I

JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

Accounts Chem. Res.
*Accounts of Chemical Research *(U. S.)*

Acta Anat. Nippon.
Acta Anatomica Nipponica
see *Kaibogaku Zasshi*

Acta Astron.
Acta Astronomica, Polska Akademia Nauk (formed by merger of Acta Astronomica, Ser. A; Ser. B; and Ser. C) *(Poland)*

Acta Entomol. Bohemoslov.
Acta Entomologica Bohemoslovaca *(Czechoslovakia)*

Acta Geod., Geophys. Montanistica
Acta Geodaetica, Geophysica et Montanistica *(Hungary)*

Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*

Acta Pharm. Hung.
Acta Pharmaceutica Hungarica *(Hungary)*

Acta Pharm. Suec.
Acta Pharmaceutica Suecica *(Sweden)*

Acta Phys. Chem.
*Acta Physica et Chemica *(Hungary)*

Acta Polytech., Chem. Met. Ser.
Acta Polytechnica, Chemistry including Metallurgy Series *(Sweden)*

Acta Sci. Natur. Univ. Pekin.
Acta Scientiarum Naturalium Universitatis Pekinensis
see *Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh*

Acta Sci. Natur., Univ. Szechuan.
Acta Scientiarum Naturalium, Universitatis Szechuanensis
see *Ssu Ch'uan Ta Hsueh Hsueh Pao–Tzu Jan K'o Hsueh*

Acta Tuberc. Pneumol. Belg.
Acta Tuberculosea et Pneumologica Belgica *(Belgium)*

Acta Univ. Carolinae, Med., Monogr.
Acta Universitatis Carolinae, Medica, Monographia *(Czechoslovakia)*

Acta Univ. Nankinensis Sci. Natur.
Acta Universitatis Nankinensis Scientiarum Naturalium
see *Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh*

Acta Univ. Upsaliensis, Abstr. Uppsala Diss. Sci.
Acta Universitatis Upsaliensis, Abstracts of Uppsala Dissertations in Science *(Sweden)*

Advan. Contr. Syst.
Advances in Control Systems *(U. S.)*

Advan. Cryog. Eng.
Advances in Cryogenic Engineering *(U. S.)*

Advan. Nucl. Phys.
Advances in Nuclear Physics *(U. S.)*

Advan. Polym. Sci.
Advances in Polymer Science
see *Fortschr. Hochpolym.-Forsch.*

Advan. X-Ray Anal.
Advances in X-Ray Analysis *(U. S.)*

Aesthet. Med.
Aesthetische Medizin *(West Germany)*

Agr. Hokkaido
Agriculture in Hokkaido
see *Hokuno*

Agr. Res. (New Delhi)
Agricultural Research (New Delhi) *(India)*

Air Clean.
Air Cleaning
see *Kuki Seijo*

Air Water Pollut.
*Air and Water Pollution (formerly International Journal of Air Water Pollution) *(U. S.–England)*

Ala. J. Med. Sci.
Alabama Journal of Medical Sciences, The *(U. S.)*

Allg. Prakt. Chem.
Allgemeine und Praktische Chemie *(Austria)*

Allg. Waermetech.
Allgemeine Waermetechnik *(West Germany)*

Alloy Dig. Zr-3
Alloy Digest Zr-3 *(U.S.)*

Amer. Dyestuff Rep.
American Dyestuff Reporter *(U. S.)*

Amer. J. Med. Technol.
American Journal of Medical Technology *(U. S.)*

Amer. Mach./Metalwork. Mfg.
American Machinist/Metalworking Manufacturing *(U. S.)*

Anal. Lett.
Analytical Letters *(U. S.)*

Ann. Acad. Sci. Fenn., Ser. A IV
Annales Academiae Scientiarum Fennicae, Series A IV *(Finland)*

Ann. Bot. Fenn.
Annales Botanici Fennici *(Finland)*

Ann. Dent.
Annals of Dentistry *(U. S.)*

Ann. Oto-Laryngol.
Annales d'Oto-Laryngologie *(France)*

Ann. Ponts Chaussees
Annales des Ponts et Chaussees *(France)*

Ann. Sanita Pubblica
Annali della Sanita Pubblica *(Italy)*

An. Stiint. Univ. Al. I. Cuza, Iasi, Sect. I
Analele Stiintifice ale Universitatii Al. I. Cuza, din Iasi, Sectiunea I *(Romania)*

Annu. ISA (Instrum. Soc. Amer.) Conf. Proc.
Annual ISA (Instrument Society of America) Conference Proceedings *(U. S.)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. DD
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio DD *(Poland)*

Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol.
*Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica *(Hungary)*

Annu. Rep. Res. Inst. Environ. Med., Nagoya Univ.
Annual Report of the Research Institute of Environmental Medicine, Nagoya University *(Japan)*

Annu. Rev. Genet.
Annual Review of Genetics *(U.S.)*

Antimicrob. Agents Chemother.
Antimicrobial Agents and Chemotherapy *(U. S.)*

An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.
Analele Universitatii Bucuresti, Seria Stiintele Naturii, Fizica *(Romania)*

Apicultura (Bucharest)
Apicultura (Bucharest) *(Romania)*

Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen
Arbeitsgemeinschaft fuer Forschung des Landes Nordrhein-Westfalen *(West Germany)*

Arbeitsmed.-Sozialmed.-Arbeitshyg.
Arbeitsmedizin-Sozialmedizin-Arbeitshygiene *(West Germany)*

Arch. Hist. Exact. Sci.
Archive for History of Exact Sciences *(West Germany–U. S.)*

Arch. Jap. Chir.
Archiv fuer Japanische Chirurgie
see *Nippon Geka Hokan*

Arch. Meteorol., Geophys. Bioklimatol., Ser. B
Archive fuer Meteorologie, Geophysik und Bioklimatologie, Series B *(Austria)*

Arch. Mineral.
Archiwum Mineralogiczne *(Poland)*

Arch. Neer. Sci. Exactes Natur.
Archives Neerlandaises des Sciences Exactes et Naturelles *(Netherlands)*

Arch. Phys. Ther.
Archiv fuer Physikalische Therapie, Balneologie und Klimatologie *(East Germany)*

Arch. Stomatol.
Archivio Stomatologico *(Italy)*

Ark. Zool.
Arkiv for Zoologi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*

ASM (Amer. Soc. Metals), Trans. Quart.
*ASM (American Society for Metals), Transactions Quarterly (formerly Transactions of the American Society for Metals) *(U. S.)*

ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.
ASTM (American Society for Testing and Materials) Special Technical Publication *(U. S.)*

Astrofizika
Astrofizika *(Armenian S.S.R.)*

Astron. Tsirk.
Astronomicheskii Tsirkulyar *(U.S.S.R.)*

Astrophysics (Engl. Transl.)
*Astrophysics (English Translation of Astrofizika) *(U. S.)*

Astrophys. Lett.
*Astrophysical Letters *(Scotland)*

Astrophys. Space Sci.
*Astrophysics and Space Science *(Netherlands)*

At. Absorption Newslett.
Atomic Absorption Newsletter *(U. S.)*

Ateneo Parmense, Sez. 1
Ateneo Parmense, Sezione 1. Acta Bio-Medica *(Italy)*

At. Energy (China)
Atomic Energy (China)
see *Yuan Tzu Neng*

At. Energy Bull.
Atomic Energy Bulletin
see *Genshiryoku Shiryo*

At. Energy Law J.
Atomic Energy Law Journal *(U. S.)*

Atmos. Environ.
*Atmospheric Environment *(England)*

Atti Accad. Med. Lombarda
Atti della Accademia Medica Lombarda *(Italy)*

Aust. J. Mar. Freshwater Res.
Australian Journal of Marine and Freshwater Research *(Australia)*

Aust. J. Zool.
Australian Journal of Zoology *(Australia)*

Aust. Mach. Prod. Eng.
Australian Machinery and Production Engineering *(Australia)*

Australas. Mfr.
Australasian Manufacturer *(Australia)*

Automat. Electron.
Automatica si Electronica *(Romania)*

Automaz. Strum.
Automazione e Strumentazione *(Italy)*

Aviat. Week Space Technol.
Aviation Week and Space Technology *(U. S.)*

Bautechnik
Bautechnik, Die *(West Germany)*

Beitr. Biol. Pflanz.
Beitraege zur Biologie der Pflanzen *(West Germany)*

Ber. Deut. Ges. Geol. Wiss., Reihe B
Berichte der Deutschen Gesellschaft fuer Geologische Wissenschaften, Reihe B. Mineralogie und Lagerstaettenforschung *(East Germany)*

Berg- Huettenmaenn: Monatsh. Montan. Hochsch. Leoben
Berg- und Huettenmaennische Monatshefte der Montanistischen Hochschule in Leoben *(West Germany)*

Berlin. Wetterkarte, Suppl.
Berliner Wetterkarte, Supplement *(West Germany)*

Ber. Schweiz. Bot. Ges.
Berichte der Schweizerischen Botanischen Gesellschaft *(Switzerland)*

Beton Zhelezobeton
Beton i Zhelezobeton *(Georgian S.S.R.)*

Biol. Nauki
Biologicheskie Nauki *(U.S.S.R.)*

Biol. Plant., Acad. Sci. Bohemoslov.
Biologia Plantarum, Academia Scientarum Bohemoslovenica *(Czechoslovakia)*

Biol. Rundsch.
Biologische Rundschau *(East Germany)*

Biul. Wojsk. Akad. Tech.
Biuletyn Wojskowej Akademii Techniczenj imeni Jaroslawa Dabrowskiego *(Poland)*

Blech
Blech *(West Germany)*

BNX Rev.
BNX Review *(England)*

Bodenkultur
Bodenkultur, Die *(Austria)*

Boll. Zool.
Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*

Bol. Univ. Fed. Parana, Fis. Teor.
*Boletim da Universidade Federal do Parana, Fisica Teorica *(Brazil)*

Brain Res.
Brain Research *(Netherlands)*

Brit. Food J.
British Food Journal *(England)*

Brit. J. Plast. Surg.
British Journal of Plastic Surgery *(Scotland)*

Brit. Mycol. Soc. Trans.
British Mycological Society Transactions, The *(England)*

Brit. Plast.
British Plastics *(England)*

Broad Way Clin. Suppl.
Broad Way Clinical Supplement *(England)*

Build. Eng.
Building Engineering
see *Kenchiku Gijutsu*

Bull. Astron.
Bulletin Astronomique *(France)*

Bull. Astron. Inst. Neth.
Bulletin of the Astronomical Institutes of the Netherlands *(Netherlands)*

Bull. Astron. Inst. Neth., Suppl. Ser.
Bulletin of the Astronomical Institutes of the Netherlands, Supplement Series *(Netherlands)*

Bull. Belgicatom
Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Paficique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

Bull. Belg. Phys. Soc.
Bulletin of the Belgian Physical Society (formerly Bulletin de la Societe Belge de Physique) *(Belgium)*

Bull. Calcutta Math. Soc.
Bulletin of the Calcutta Mathematical Society *(India)*

Bull. Dir. Etud. Rech.
Bulletin de la Direction des Etudes et Recherches *(France)*

Bull. Earthquake Res. Inst., Univ. Tokyo
Bulletin of the Earthquake Research Inst., University of Tokyo
see *Tokyo Daigaku Jishin Kenkyusho Iho*

Bull. Eidgenoess. Gesundh., Beil. B
Bulletin des Eidgenoessisches Gesundheitsamtes, Beilage B *(Switzerland)*

Bull., Eng. Geol. Hydrogeol. (Engl. Transl.)
Bulletin, Engineering Geology and Hydrogeology (English Translation of Vesnik Zavoda za Geoloska i Geofizicka Istrazivanja, Serija B) *(Yugoslavia)*

Bull. Entomol. Res.
Bulletin of Entomological Research *(England)*

Bull. Fac. Eng., Hiroshima Univ.
Bulletin of the Faculty of Engineering, Hiroshima University
see *Hiroshima Daigaku Kogakubu Kenkyu Hokoku*

Bull. Fac. Sci. Eng., Chuo Univ.
Bulletin of the Faculty of Science and Engineering, Chuo University

see Chuo Daigaku Rikogakubu Kiyo

Bull. Geophys. Observ., Haile Sellassie I Univ.
Bulletin of the Geophysical Observatory, Haile Sellassie I University *(Ethopia)*

Bull. Govt. Ind. Res. Inst., Osaka
Bulletin of the Government Industrial Research Institute, Osaka
see Osaka Kogyo Gijutsu Shikensho Kiho

Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl.
*Bulletin d'Information A.T.E.N. (Association Technique pour l'Energie Nucleaire), Supplement *(France)*

Bull. Inst. Geophys., Nat. Cent. Univ.
*Bulletin of the Institute of Geophysics, National Central University *(China (Taiwan))*

Bull. Inst. Int. Froid, Annexe
Bulletin de l'Institut International du Froid, Annexe *(France)*

Bull. Inst. Nat. Sante Rech. Med.
Bulletin de l'Institut National de la Sante et de la Recherche Medicale *(France)*

Bull. Instrum. Nucl.
*Bulletin Instrumentation Nucleaire (formerly Instrumentation Nucleaire) Supplement au Bulletin d'Informations Scientifiques et Techniques *(France)*

Bull. Inst. Space Aeronaut. Sci., Univ. Tokyo
Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo
see Tokyo Daigaku Uchu Koku Kenkyusho Hokoku

Bull Int. Inst. Refrig., Suppl.
Bulletin of the International Institute of Refrigeration, Supplement
see Bull. Inst. Int. Froid, Annexe

Bull. Kyoto Educ. Univ., Ser. B
Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*

Bull. Office Int. Epizoot.
Bulletin de l'Office International des Epizooties *(France)*

Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.
Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
see Tohoku Daigaku Senko Seiren Kenkyusho Iho

Bull. Soc. Roy. Bot. Belg.
Bulletin de la Societe Royale de Botanique de Belgique *(Belgium)*

Bull. Soc. Sea Water Sci., Jap.
Bulletin of the Society of Sea Water Science, Japan
see Nippon Kaisui Gakkaishi

Bull. Tulane Univ. Med. Fac.
Bulletin of the Tulane University Medical Faculty *(U.S.)*

Bull. Volcanol.
Bulletin Volcanologique *(Italy)*

Bul. Stiint. Teh. Inst. Politeh. Timisoara
Buletinul Stiintific si Tehnic al Institutului Politehnic Timisoara *(Romania)*

Bus. Rev., Univ. Wash.
Business Review, University of Washington *(U. S.)*

Bus. Syst. Equip.
Business Systems and Equipment *(England)*

Bus. Week
Business Week *(U. S.)*

Byggmesteren
Byggmesteren (Norges Byggforskningsinstitutt) *(Norway)*

Byull. Inst. Teor. Astron.
Byulleten Instituta Teoreticheskoi Astronomii *(U.S.S.R.)*

Byull. Kom. Opred. Absol. Geol. Form.
Byulleten Komissii po Opredeleniyu Absolyutnogo Vozrasta Geologicheskikh Formatsii *(U.S.S.R.)*

CA—Cancer J. Clin.
CA— Cancer Journal Clinicians *(U.S.)*

Cah. Ing. Agron.
Cahiers des Ingenieurs Agronomes *(France)*

Cah. Oceanogr.
Cahiers Oceanographiques *(France)*

Calcified Tissue Res.
Calcified Tissue Research *(West Germany)*

Can. Hosp.
Canadian Hospital *(Canada)*

Can. J. Ophthalmol.
Canadian Journal of Ophthalmology *(Canada)*

Can. J. Psychol.
Canadian Journal of Psychology *(Canada)*

Can. Mach. Metalwork.
Canadian Machinery and Metalworking *(Canada)*

Canner/Packer
Canner/Packer *(U. S.)*

Can. Nurse
Canadian Nurse *(Canada)*

Cell Tissue Kinet.
*Cell and Tissue Kinetics *(England)*

Celul. Hirtie
*Celuluza si Hirtie *(Romania)*

Cent. Afr. J. Med.
Central African Journal of Medicine *(Rhodesia)*

Cercet. Met.
Cercetari Metalurgice *(Romania)*

Chartered Mech. Eng.
Chartered Mechanical Engineer *(England)*

Chem. Heterocycl. Compounds (USSR) (Engl. Transl.)
Chemistry of Heterocyclic Compounds (USSR) (English Translation of Khimiya Geterotsiklicheskikh Soedinenii) *(U. S.)*

Chem. Instrum.
*Chemical Instrumentation *(U. S.)*

Chem. Process. (London)
Chemical Processing (London) *(England)*

Chem. Rundsch. (Solothurn)
Chemische Rundschau (Solothurn) *(Switzerland)*

Chesapeake Sci.
Chesapeake Science *(U. S.)*

Chicago Med. Sch. Quart.
Chicago Medical School Quarterly *(U. S.)*

Chim. Ind., Genie Chim.
Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*

Chin. Agr. Sci.
Chinese Agricultural Science
see Chung Kuo Nung Yeh K'o Hsueh

Chin. Anim. Husb. Vet. Med.
Chinese Animal Husbandry and Veterinary Medicine
see Chung Kuo Hsu Mu Shou I

Chin. J. Dermatol.
Chinese Journal of Dermatology
see Chung Hua P'i Fu K'o Tsa Chih

Chin. J. Gynecol. Obstet.
Chinese Journal of Gynecology and Obstetrics
see Chung Hua Fu Ch'an K'o Tsa Chih

Chin. J. Phys. (Peking) (Engl. Transl.)
*Chinese Journal of Physics (Peking) (English Translation of Acta Physica Sinica (Wu Li Hsueh Pao)) *(U. S.)*

Chin. J. Surg.
Chinese Journal of Surgery
see Chung Hua Wai K'o Tsa Chih

Chromatographia
Chromatographia *(West Germany)*

Chung Hua Fu Ch'an K'o Tsa Chih
Chung Hua Fu Ch'an K'o Tsa Chih (Chinese Journal of Gynecology and Obstetrics) *(China)*

Chung Hua I Hsueh Tsa Chih
Chung Hua I Hsueh Tsa Chih (National Medical Journal of China) *(China)*

Chung Hua P'i Fu K'o Tsa Chih
Chung Hua P'i Fu K'o Tsa Chih (Chinese Journal of Dermatology) *(China)*

Chung Hua Wai K'o Tsa Chih
Chung Hua Wai K'o Tsa Chih (Chinese Journal of Surgery) *(China)*

Chung Kuo Hsu Mu Shou I
Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*

Chung Kuo Nung Yeh K'o Hsueh
Chung Kuo Nung Yeh K'o Hsueh (Chinese Agricultural Science) *(China)*

Chuo Daigaku Rikogakubu Kiyo
Chuo Daigaku Rikogakubu Kiyo (Bulletin of the Faculty of Science and Engineering, Chuo University) *(Japan)*

Civil Eng. (N. Y.)
Civil Engineering (New York) *(U. S.)*

Civil Eng. Public Works Rev.
Civil Engineering and Public Works Review *(England)*

Clay Sci. (Tokyo)
Clay Science (Tokyo) *(Japan)*

Cleveland Clin. Quart.
Cleveland Clinic Quarterly *(U. S.)*

Clin. Med.
Clinical Medicine *(U. S.)*

Coal Age
Coal Age *(U. S.)*

Cobalt
Cobalt *(France)*

Colloid J. (USSR) (Engl. Transl.)
Colloid Journal (USSR) (English Translation of Kolloidnyi Zhurnal) *(U. S.)*

Colloq. Int. Cent. Nat. Rech. Sci.

Colloques Internationaux du Centre National de la Recherche Scientifique *(France)*

Colo., Agr. Exp. Sta., Tech. Bull.
Colorado State University, Agricultural Experiment Station, Technical Bulletin *(U. S.)*

Combustion
Combustion *(U.S.)*

Commer. Fish. Rev.
Commercial Fisheries Review *(U. S.)*

Commun. Math. Phys.
Communications in Mathematical Physics *(West Germany)*

Compt. Rend. Soc. Geol. Fr.
Compte Rendu Sommaire des Seances de la Societe Geologique de France *(France)*

Comput. Biomed. Res.
Computers and Biomedical Research *(U. S.)*

Concrete J.
Concrete Journal
see **Konkurito Janaru**

Constr. Masini
Constructia de Masini *(Romania)*

Coord. Chem. Rev.
Coordination Chemistry Reviews *(Netherlands)*

Corros. Prev. Contr.
Corrosion Prevention and Control *(England)*

Cuivre, Laitons, Alliages
Cuivre, Laitons, Alliages *(France)*

Curr. Awareness Bull.
Current Awareness Bulletin *(U. S.)*

Curr. Mod. Biol.
Currents in Modern Biology *(Netherlands)*

Czas. Stomatol.
Czasopismo Stomatologiczne *(Poland)*

Dan. Med. Bull.
Danish Medical Bulletin *(Denmark)*

Denki Shikenjo Kenkyu Hokoku
Denki Shikenjo Kenkyu Hokoku (Researches of the Electrotechnical Laboratory) *(Japan)*

Desalination
Desalination *(Netherlands)*

Des. Components Eng.
Design and Components in Engineering *(England)*

Deut. Apoth.-Ztg.
Deutsche Apotheker-Zeitung Vereinigt mit Sueddeutsche Apotheker-Zeitung *(West Germany)*

Deut. Hydrogr. Z.
Deutsche Hydrographische Zeitschrift *(West Germany)*

Deut. Zahn-, Mund- Kieferheilk.
Deutsche Zahn-, Mund- und Kieferheilkunde mit Zentralblatt fuer die Gesamte Zahn-, Mund- und Kieferheilkunde *(East Germany)*

Deut. Z. Gesam. Gerichtl. Med.
Deutsche Zeitschrift fuer die Gesamte Gerichtliche Medizin *(West Germany–U. S.)*

Diffus. Data
*Diffusion Data *(U. S.)*

DMIC Rev.
DMIC Review of Recent Developments *(U. S.)*

Doboku Gijutsu
Doboku Gijutsu (Civil Engineering) *(Japan)*

Doc-Air-Espace
*Doc-Air-Espace *(France)*

Dokl.–Bot. Sci. Sect. (Engl. Transl.)
Doklady–Botanical Sciences Sections (English Translation) *(U.S.)*

Dokl. TSKhA (Timiryazev. Sel'skokhoz. Akad.)
Doklady TSKhA (Timiryazevskaya Sel'skokhozyaistvennaya Akademiya) *(U.S.S.R.)*

Drevo
Drevo *(Czechoslovakia)*

Earth-Sci. Rev.
Earth-Science Reviews *(Netherlands)*

Eiyo To Shokuryo
Eiyo To Shokuryo (Journal of Japanese Society of Food and Nutrition) *(Japan)*

Ekon. Samf. Tidskr.
Ekonomiska Samfundets Tidskrift *(Sweden)*

Electron. Equip. News
Electronic Equipment News *(England)*

Electron. Ind. (Paris).
Electronique Industrielle (Paris) *(France)*

Electron. Packag. Prod.
Electronic Packaging and Production *(U. S.)*

Electrotechniek
Electrotechniek *(Netherlands)*

Elec. World
Electrical World *(U. S.)*

Elec. World (Shanghai)
Electrical World (Shanghai)
see **Tien Shih Chieh**

Elektrizitaetsverwertung
Elektrizitaetsverwertung *(Switzerland)*

Elektromedizin
Elektromedizin und Ihre Grezgebiete *(Germany)*

Elektron. Bol'shikh Moshch.
Elektronika Bol'shikh Moshchnostei *(U.S.S.R.)*

Elektron. Obrab. Mater.
Elektronnaya Obrabotka Materialov *(Moldavian S.S.R.)*

Elektron. Rechenanlagen
Elektronische Rechenanlagen *(West Germany)*

Elektrotech. Cas.
Elektrotechnicky Casopis *(Czechoslovakia)*

Elektrotekhnika
Elektrotekhnika *(U.S.S.R.)*

Elektr. Sta.
Elektricheskie Stantsii *(U.S.S.R.)*

Energetika
*Energetika *(Czechoslovakia)*

Engei Gakkai Zasshi
Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*

Engl. Elec. J.
English Electric Journal *(England)*

Entropie
Entropie *(France)*

Environ. Health
Environmental Health *(India)*

Environ. Res.
Environmental Research *(U. S.)*

EPE, Rev. Energ. Primaire
EPE, Revue Energie Primaire
see **Rev. Energ. Primaire**

Ergonomics
Ergonomics *(England)*

Euphytica
Euphytica *(Netherlands)*

Euratom Rev.
*Euratom Review of the European Atomic Energy Community (formerly Euratom Bulletin) *(Belgium)*

Exp. Pathol.
Experimentelle Pathologie *(East Germany)*

Farm, Ranch, Home Quart.
Farm, Ranch and Home Quarterly *(U. S.)*

FDA (Food Drug Admin.) Pap.
FDA (Food and Drug Administration) Papers *(U. S.)*

Fette-Seifen-Anstrichm.
Fette-Seifen-Anstrichmittel (combined with Ernaehrungsindustrie) *(West Germany)*

Fiz. Chastits Vys. Energ., Akad. Nauk Gruz. SSSR, Inst. Fiz.
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*

Fiziol. Norm. Patol. (Bucharest)
Fiziologia Normala si Patologica (Bucharest) *(Romania)*

Fiz. Khim. Obrab. Mater.
Fizika i Khimiya Obrabotki Materialov *(U.S.S.R.)*

Fiz. Tekh. Poluprov.
*Fizika i Tekhnika Poluprovodnikov *(U.S.S.R.)*

Flame Notes, Beckman
Flame Notes, Beckman *(U. S.)*

Flug-Rev. Int.
Flug-Revue International *(West Germany)*

FOA (Forsvarets Forsk.) Rep.
*FOA (Forsvarets Forskningsanstalt) Reports *(Sweden)*

Folia Haematol. (Leipzig)
Folia Haematologia (Leipzig) *(East Germany)*

Folia Med. Cracov.
Folia Medica Cracoviensia *(Poland)*

Food Eng. (Philadelphia)
Food Engineering (Philadelphia) (formerly Food Industries) *(U. S.)*

Forest. Abstr.
Forestry Abstracts *(England)*

Forsch. Ingenieurw.
Forschung im Ingenieurwesen *(West Germany)*

Fortschr. Hochpolym.-Forsch.
Fortschritte der Hochpolymeren-Forschung *(West Germany)*

Fortschr. Zool.
Fortschritte de Zoologie *(West Germany)*

Foundry
Foundry *(U. S.)*

Freiberg. Forschungsh., B
Freiberger Forschungshefte, Reihe B *(East Germany)*

Fukuoka Acta Med.
Fukuoka Acta Medica
see *Fukuoka Igaku Zasshi*

Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*

Fukushima Daigaku Gakugei Gakubu Rika Hokoku
Fukushima Daigaku Gakugei Gakubu Rika Hokoku (The Science Reports of the Faculty of Arts and Science, Fukushima University) *(Japan)*

Fune No Kagaku
Fune No Kagaku (Marine Engineering) *(Japan)*

Genet. Pol.
*Genetica Polonica *(Poland)*

Genshiryoku Shiryo
Genshiryoku Shiryo (Atomic Energy Bulletin) *(Japan)*

Geofiz. App.
Geofizicheskaya Apparatura *(U.S.S.R.)*

Geofiz. Byull.
Geofizicheskii Byulleten *(U.S.S.R.)*

Geofys. Sb.
Geofysikalni Sbornik *(Czechoslovakia)*

Geol. Geofiz.
Geologiya i Geofizika *(U.S.S.R.)*

Geol. Mag.
Geological Magazine *(England)*

Geol. Nefti Gaza
Geologiya Nefti i Gaza† *(U.S.S.R.)*

Geol. Soc. Amer., Spec. Pap.
Geological Society of America, Special Paper *(U. S.)*

Geophys. Geol. (Leipzig)
Geophysik und Geologie (Leipzig) *(East Germany)*

Gidroaeromekhanika
Gidroaeromekhanika *(Ukrainian S.S.R.)*

Gidrokhim. Mater.
Gidrokhimicheskie Materialy *(U.S.S.R.)*

Giesserei
Giesserei *(West Germany)*

G–I–T (Glas- Instrum.-Tech.) Fachz. Lab.
G–I–T (Glas- und Instrumenten-Technik) Fachzietschrift fuer das Laboratorium *(West Germany)*

Glas-Instrum.-Tech.
Glas-Instrumenten-Technik *(West Germany)*

Glass Ceram. (USSR) (Engl. Transl.)
Glass and Ceramics (USSR) (English Translation of Steklo i Keramika) *(U. S.)*

Gorn. Zh.
Gornyi Zhurnal *(U.S.S.R.)*

Grinding Finish.
Grinding and Finishing *(U. S.)*

Gueisuanyan Xuebao
Gueisuanyan Xuebao
see *Kuei Suan Yen Hsueh Pao*

Haematologia (Budapest)
Haematologia (Budapest) *(Hungary)*

Haikan Gijutsu
Haikan Gijutsu (The Piping Engineering) *(Japan)*

Handb. Med. Radiol.
Handbuch der Medizinschen Radiologie *(West Germany)*

Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*

Hawaii Farm Sci.
Hawaii Farm Science *(U. S.)*

Health Lab. Sci.
Health Laboratory Science *(U. S.)*

Heidelberg. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber.
Heidelberger Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse, Sitzungsberichte *(West Germany)*

Hemel Dampkring
Hemel en Dampkring *(Belgium)*

Hiroshima Daigaku Kogakubu Kenkyu Hokoku
Hiroshima Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the Faculty of Engineering, Hiroshima University) *(Japan)*

Hodowla Rosl., Aklim. Nasien.
Hodowla Roslin, Aklimatyzacja i Nasiennictwo *(Poland)*

Hoken Butsuri
Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*

Hokkaidoritsu Eisei Kenkyushoho
Hokkaidoritsu Eisei Kenkyushoho (Report of the Hokkaido Inst. of Public Health) *(Japan)*

Hokuno
Hokuno (Agriculture in Hokkaido) *(Japan)*

Honvedorvos
Honvedorvos *(Hungary)*

Hyg. Sanit. (USSR) (Engl. Transl.)
Hygiene and Sanitation (USSR) (English Translation of Gigiena i Sanitariya) *(U. S.)*

Hyogo Noka Daigaku Kiyo
Hyogo Noka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*

Idengaku Zasshi, Suppl.
Idengaku Zasshi, Supplement (Japanese Journal of Genetics, Supplement) *(Japan)*

IEEE (Inst. Elec. Electron. Eng.) Trans. Audio Electroacoust.
*IEEE (Institute of Electrical and Electronics Engineers) Transactions on Audio and Electroacoustics *(U.S.)*

Ig. Sanita Pubblica
Igiene e Sanita Pubblica *(Italy)*

Ind. Aliment. Agr. (Paris)
Industries Alimentaires et Agricoles (Paris) *(France)*

Ind.-Anz.
Industrie-Anzeiger *(West Germany)*

Ind.-Elektron. Forsch. Fertigung
Industrie-Elektronik in Forschung und Fertigung *(West Germany)*

Indian Food Packer
Indian Food Packer *(India)*

Indian J. Agr. Sci.
Indian Journal of Agricultural Science, The *(India)*

Indian J. Appl. Chem.
Indian Journal of Applied Chemistry *(India)*

Indian J. Cancer
Indian Journal of Cancer *(India)*

Indian J. Occup. Health
Indian Journal of Occupational Health *(India)*

Indian J. Pathol. Bacteriol.
Indian Journal of Pathology and Bacteriology *(India)*

Indian Pediat.
Indian Pediatrics *(India)*

Ind. Mineraria
Industria Mineraria *(Italy)*

Ind. Process Heat.
Industrial and Process Heating *(England)*

Ind. Water Eng.
Industrial Water Engineering *(U. S.)*

Inform. Byull. Sov. Antarkt. Eksped.
Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*

Ing. Bygningsv., Ugeovers.
Ingenieor- og Bygningsvaesen, Ugeoversigt *(Denmark)*

Inst. Mining Met., Trans./Sect. B
Institution of Mining and Metallurgy, Transactions/Section B. Applied Earth Science (continues in part Transactions of the Institution of Mining and Metallurgy) *(England)*

Inst. Petrol. Rev.
Institute of Petroleum Review, The *(England)*

Instrum. Contr. Eng.
Instrument and Control Engineering *(England)*

Instrum. Med.
Instrumentation in Medicine *(England)*

Int. Ass. Sci. Hydrol., Bull.
International Association of Scientific Hydrology, Bulletin *(Belgium)*

Int. Chem. Eng.
*International Chemical Engineering. A Quarterly Journal of Translations from Russia, Eastern Europe, and Asia *(U. S.)*

Int. Dig. Health Legislation
International Digest of Health Legislation *(Switzerland)*

Int. J. Mass Spectrom. Ion Phys.
International Journal of Mass Spectrometry and Ion Physics
see *J. Mass Spectrom. Ion Phys.*

Int. J. Neurol.
International Journal of Neurology *(U. S.)*

Int. J. Theor. Phys.
International Journal of Theoretical Physics *(England)*

Int. Rev. Gesam. Hydrobiol.
Internationale Revue der Gesamten Hydrobiologie *(East Germany)*

Int. Surg.
International Surgery *(U. S.)*

Inzh. Zh., Mekh. Tverd. Tela
Inzhenernyi Zhurnal, Mekhanika Tverdogo Tela (formerly Inzhenernyi Zhurnal) *(U.S.S.R.)*

Iron Age Metalwork. Int.
Iron Age Metalworking International *(U. S.)*

ISA (Instrum. Soc. Amer.), Proc., Nat. Power Instrum. Symp.
ISA (Instrument Society of America), Proceedings, National Power Instrumentation Symposium *(U. S.)*

Issled. Genet.
Issledovaniya po Genetike *(U.S.S.R.)*

Issled. Primen. Tsifrovykh Analogovykh Vychisl. Mash. Yad. Fiz.

Tekh., Sb. Statei (U.S.S.R.)
*Issledovanie Primenenii Tsifrovykh i Analogovykh Vychislitel'nykh Mashin v Yadernoi Fizike i Tekhnike, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*

Izobret., Prom. Obraztsy, Tovarnye Znaki
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Biol. Nauki
Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie Nauki (superseded by Biologicheskii Zhurnal Armenii) *(Armenian S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Ser. Tekh. Nauk
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Tekhnicheskikh Nauk *(Armenian S.S.R.)*

Izv. Akad. Nauk Kaz. SSR, Ser. Khim.
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Khimicheskaya *(Kazakh S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk, Mekh. Mashinostr.
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Biol.
Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Geol.
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Mat.
Izvestiya Akademii Nauk SSSR, Seriya Matematicheskaya *(U.S.S.R.)*

Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Tekh. Khim. Nauk
Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie Fiziko-Tekhnicheskikh i Khimicheskikh Nauk *(Tadzhik S.S.R.)*

Izv. Akad. Nauk Uzb. SSR, Ser. Tekh. Nauk
Izvestiya Akademii Nauk Uzbekskoi SSR, Seriya Tekhnicheskikh Nauk *(Uzbek S.S.R.)*

Izv. Inst. Elektron., Bulg. Akad. Nauk.
Izvestiya na Instituta po Elektronika, Bulgarska Akademiya na Naukite *(Bulgaria)*

Izv. Inst. Khidrol. Meteorol., Bulg. Akad. Nauk.
Izvestiya na Instituta po Khidrologiya i Meteorologiya, Bulgarska Akademiya na Naukite, Otdelenie za Matematicheski i Fizicheski Nauki *(Bulgaria)*

Izv. Vost. Filial. Akad. Nauk SSSR
Izvestiya Vostochniykh Filialov Akademii Nauk SSSR *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Mat.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Priborostr.
Izvestiya Vysshikh Uchebnykh Zavedenii, Priborostroenie *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Tekhnol. Legk. Prom.
Izvestiya Vysshikh Uchebnykh Zavedenii, Tekhnologiya Legkoi Promyshlennosti *(Ukrainian S.S.R.)*

J. Amer. Podiat. Ass.
Journal of the American Podiatry Association *(U. S.)*

Jap. J. Dairy Sci.
Japanese Journal of Dairy Science (Japan)
see *Rakuno Kagaku no Kenkyu*

Jap. J. Exp. Morphol.
Japanese Journal of Experimental Morphology
see *Jikken Keitaigakushi*

Jap. J. Genet., Suppl.
Japanese Journal of Genetics, Supplement
see *Idengaku Zasshi, Suppl.*

Jap. J. Pharm. Chem.
Japanese Journal of Pharmacy and Chemistry
see *Yakugaku Kenkyu*

Jap. J. Zootech. Sci.
Japanese Journal of Zootechnical Science
see *Nippon Chikusangaku Kaiho*

JARE Sci. Rep., Spec. Issue
JARE Scientific Reports, Special Issue *(Japan)*

J. Ass. Phys. Ment. Rehabil.
Journal of the Association for Physical and Mental Rehabilitation *(U. S.)*

J. Ass. Public Anal.
Journal of the Association of Public Analysts *(England)*

J. Aust. Ceram. Soc.
Journal of the Australian Ceramic Society *(Australia)*

J. Balneol. Soc. Jap.
Journal of the Balneological Society of Japan
see *Onsen Kagaku*

J. Belge Radiol., Monogr.
*Journal Belge de Radiologie, Monographie *(Belgium)*

J. Biol. Photogr. Ass.
Journal of the Biological Photographic Association, The *(U. S.)*

J. Brit. Ceram. Soc.
Journal of the British Ceramic Society, The *(England)*

J. Cell Sci.
*Journal of Cell Science *(England)*

J. Chin. Silicates Soc.
Journal of the Chinese Silicates Society
see *Kuei Suan Yen Hsueh Pao*

J. Comb. Theory
Journal of Combinatorial Theory *(U. S.-England)*

J. Cons. Perma. Int. Explor. Mer
Journal du Conseil, Conseil Permanent International pour l'Exploration de la Mer *(Denmark)*

J. Cryst. Growth
Journal of Crystal Growth *(Netherlands)*

J. Curr. Laser Abstr.
Journal of Current Laser Abstracts *(Canada)*

J. Egypt. Public Health Ass.
Journal of the Egyptian Public Health Association *(Egypt)*

Jemna Mech. Opt.
Jemna Mechanika a Optika *(Czechoslovakia)*

Jeune Sci.
Jeune Scientifique *(Canada)*

J. Food Sci. Technol.
Journal of Food Science and Technology
see *Nippon Shokuhin Kogyo Gakkaishi*

J. Forensic Med.
Journal of Forensic Medicine *(South Africa)*

J. Formosan Med. Ass.
Journal of the Formosan Medical Association
see *T'ai-wan I Hsueh Hui Tsa Chih*

J. Fuel Heat. Technol.
Journal of Fuel and Heating Technology *(England)*

J. Geol.
Journal of Geology *(U. S.)*

J. High Polym. (Shanghai)
Journal of High Polymers (Shanghai)
see *Kao Fen Tzu T'ung Hsun*

Jibiinkoka Rinsho
Jibiinkoka Rinsho (Oto-Rhino-Laryngological Clinic) *(Japan)*

Jikken Keitaigakushi
Jikken Keitaigakushi (Japanese Journal of Experimental Morphology) *(Japan)*

J. Indian Soc. Soil Sci.
Journal of the Indian Society of Soil Science *(India)*

J. Inst. Safety High Pressure Gas Eng.
Journal of the Inst. of Safety of High Pressure Gas Engineering
see *Koatsu Gasu*

J. Inst. Telecommun. Eng.
Journal of the Institution of Telecommunication Engineers *(India)*

J. Irish Med. Ass.
Journal of the Irish Medical Association *(Ireland)*

J. Irrig. Drain. Div., Amer. Soc. Civil Eng.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Jap. Health Phys. Soc.
Journal of Japan Health Physics Society
see *Hoken Butsuri*

J. Jap. Med. Ass.
Journal of the Japan Medical Association, The
see *Nippon Ishikai Zasshi*

J. Jap. Petrol. Inst.
Journal of the Japan Petroleum Institute
see *Sekiyu Gakkaishi*

J. Jap. Soc. Food Nutr.
Journal of Japanese Society of Food and Nutrition
see *Eiyo To Shokuryo*

J. Jap. Soc. Hort. Sci.
Journal of the Japanese Society for Horticultural Science
see *Engei Gakkai Zasshi*

J. Jap. Stomatol. Soc.
Journal of the Japan Stomatological Society, The
see *Kokubyo Gakkai Zasshi*

J. Jap. Tech. Ass. Pulp Pap. Ind.
Journal of the Japanese Technical Association of Pulp and Paper Industry
see Kami Pa Gikyoshi

J. Jap. Wood Res. Soc.
Journal of the Japan Wood Research Society
see *Mokuzai Gakkaishi*

J. Karnatak Univ.
Journal of the Karnatak University *(India)*

J. Macromol. Sci., Part A
Journal of Macromolecular Science, Part A. Chemistry (supersedes Journal of Macromolecular Chemistry) *(U. S.)*

J. Maine Med. Ass.
Journal of the Maine Medical Association *(U. S.)*

J. Marine Res.
Journal of Marine Research (Sears Foundation for Marine Research) *(U.S.)*

J. Mass Spectrom. Ion Phys.
*Journal of Mass Spectrometry and Ion Physics *(Netherlands)*

J. Metal Finish. Soc. Jap.
Journal of the Metal Finishing Society of Japan, The
see *Kinzoku Hyomen Gijutsu*

J. Mol. Struct.
*Journal of Molecular Structure *(Netherlands)*

J. Nagasaki Med. Ass., Suppl.
Journal of the Nagasaki Medical Association, Supplement
see *Nagasaki Igakkai Zasshi, Suppl.*

J. Neurol. Sci.
Journal of the Neurological Sciences *(Netherlands)*

J. Nucl. Med., Suppl.
*Journal of Nuclear Medicine, Supplement *(U.S.)*

J. Nucl. Sci. (Seoul)
*Journal of Nuclear Sciences (Seoul) (Wonjaryogwon. Yon'gu Nonmun Chip) *(South Korea)*

J. Obstet. Gynaecol. India
Journal of Obstetrics and Gynaecology of India *(India)*

J. Optimization Theory Appl.
Journal of Optimization Theory and Applications *(U. S.)*

J. Oral Surg.
Journal of Oral Surgery *(U. S.)*

J. Osaka Univ. Dent. Soc.
Journal of the Osaka University Dental Society, The
see *Osaka Daigaku Shigaku Zasshi*

J. Otolaryngol. Soc. Aust.
Journal of the Otolaryngological Society of Australia *(Australia)*

J. Paleontol.
Journal of Paleontology *(U.S.)*

J. Phys., A (London)
*Journal of Physics, A (London), Proceedings of the Physical Society (General) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., B (London)
*Journal of Physics, B (London), Proceedings of the Physical Society (Atomic and Molecular Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., C (London)
*Journal of Physics, C (London), Proceedings of the Physical Society (Solid State Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., E (London)
*Journal of Physics, E (London) (supersedes Journal of Scientific Instruments) *(England)*

J. Phys. Chem. Solids, Suppl.
*Journal of Physics and Chemistry of Solids, Supplement *(England)*

J. Phys. Soc. Jap., Suppl.
*Journal of the Physical Society of Japan, Supplement *(Japan)*

J. Proc. Inst. Chem. (India)
Journal and Proceedings of the Institution of Chemists (India) *(India)*

J. Radioanal. Chem.
*Journal of Radioanalytical Chemistry *(Netherlands–Hungary)*

J. Radiol. Phys. Ther., Univ. Kanazawa
Journal of Radiology and Physical Therapy, University of Kanazawa, The
see *Kanazawa Irigaku Sosho*

J. Roy. Army Med. Corps
Journal of the Royal Army Medical Corps *(England)*

J. Sediment. Petrol.
Journal of Sedimentary Petrology *(U. S.)*

J. Soc. Eng. Miner. Springs, Jap.
Journal of the Society of Engineers for Mineral Springs, Japan
see *Onsen Kogakkaishi*

J. Soc. Fiber Sci. Technol., Jap.
Journal of the Society of Fiber Science and Technology, Japan
see *Sen'i Gakkaishi*

J. Soc. Instrum. Contr. Eng.
Journal of the Society of Instrument and Control Engineers
see *Keisoku To Seigyo*

J. Soc. Leather Trades Chem.
Journal of the Society of Leather Trades Chemists *(England)*

J. Soc. Rubber Ind., Jap.
Journal of the Society of Rubber Industry, Japan
see *Nippon Gomu Kyokaishi*

J. Tokyo Women's Med. Coll.
Journal of Tokyo Women's Medical College
see *Tokyo Joshi Ika Daigaku Zasshi*

Jugoslov. Pronalazastvo
Jugoslovensko Pronalazastvo *(Yugoslavia)*

Kagaku Keisatsu Kenkyusho Hokoku
Kagaku Keisatsu Kenkyusho Hokoku (Reports of the National Research Inst. of Police Science) *(Japan)*

Kagoshima Daigaku Suisangakubu Kiyo
Kagoshima Daigaku Suisangakubu Kiyo (Memoirs of the Faculty of Fisheries, Kagoshima University) *(Japan)*

Kaibogaku Zasshi
Kaibogaku Zasshi (Acta Anatomica Nipponica) *(Japan)*

Kali Steinsalz
Kali und Steinsalz *(West Germany)*

Kami Pa Gikyoshi
Kami Pa Gikyoshi (Journal of the Japanese Technical Association of Pulp and Paper Industry) *(Japan)*

Kanazawa Irigaku Sosho
Kanazawa Irigaku Sosho (Journal of Radiology and Physical Therapy, University of Kanazawa, The) *(Japan)*

Kao Fen Tzu T'ung Hsun
Kao Fen Tzu T'ung Hsun (Journal of High Polymers) *(China)*

Keisoku To Seigyo
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*

Kenchiku Gijutsu
Kenchiku Gijutsu (Building Engineering) *(Japan)*

Kernenergie, Beil.
*Kernenergie, Beilage *(East Germany)*

Kinzoku Hyomen Gijutsu
Kinzoku Hyomen Gijutsu (The Journal of the Metal Finishing Society of Japan) *(Japan)*

Kleinheubacher Ber.
Kleinheubacher Berichte *(East Germany)*

Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(West Germany)*

Koatsu Gasu
Koatsu Gasu (Journal of the Inst. of Safety of High Pressure Gas Engineering) *(Japan)*

Kobe Kogyo Giho
Kobe Kogyo Giho (Kobe Kogyo Technical Report) *(Japan)*

Kobe Kogyo Tech. Rep.
Kobe Kogyo Technical Report
see *Kobe Kogyo Giho*

K'o Hsueh Tz Chung
K'o Hsueh Tz Chung (Popular Science) *(China)*

Kokubyo Gakkai Zasshi
Kokubyo Gakkai Zasshi (Journal of the Japan Stomatological Society, The) *(Japan)*

Konkurito Jonaru
Konkurito Jonaru (Concrete Journal) *(Japan)*

Konserv. Ovoshchesush. Prom.
Konservnaya i Ovoshchesushil'naya Promyshlennost *(U.S.S.R.)*

Korroz. Metal. Splavov
Korroziya Metallov i Splavo *(U.S.S.R.)*

Kosm. Biol. Med.
Kosmicheskaya Biologiya i Meditsina *(U.S.S.R.)*

Kosm. Luchi
Kosmicheskie Luchi *(U.S.S.R.)*

Kovove Mater.
Kovove Materialy *(Czechoslovakia)*

Kowan Giken Shiryo
Kowan Giken Shiryo (Technical Note of Port and Harbour Technical Research Inst., Ministry of Transportation, Japan) *(Japan)*

Krist. Tech.
Kristall und Technik *(East Germany)*

Kuei Suan Yen Hsueh Pao
Kuei Suan Yen Hsueh Pao (Journal of the Chinese Silicates Society) *(China)*

Kuki Seijo
Kuki Seijo (Air Cleaning) *(Japan)*

Kumamoto Daigaku Kogakubu Kenkyu Hokoku
Kumamoto Daigaku Kogakubu Kenkyu Hokoku (Technical Reports of the Kumamoto University) *(Japan)*

Kumamoto Daigaku Kyoikugakubu Kiyo
Kumamoto Daigaku Kyoikugakubu Kiyo (Memoirs of the Faculty of Education, Kumamoto University) *(Japan)*

Kurznachr. Akad. Wiss. Goettingen
Kurznachrichten der Akademie der Wissenschaften in Goettingen *(West Germany)*

Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku (Report of the Training Inst. for Engineering Teachers, Kyoto University) *(Japan)*

Kyushu Daigaku Kogaku Shuho
Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) *(Japan)*

Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku (The Reports of the Research Inst. of Science and Industry, Kyushu University) *(Japan)*

Lahey Clin. Found. Bull.
Lahey Clinic Foundation Bulletin (formerly Lahey Clinic Bulletin) *(U. S.)*

Lakokrasoch. Mater. Ikh Primen.
Lakokrasochnye Materialy i Ikh Primenenie *(U.S.S.R.)*

Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (The Lanchow University Journal, The Natural Sciences) *(China)*

Lanchow Univ. J., Natur. Sci.
Lanchow University Journal, The, The Natural Sciences
see Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh

Landbouwtijdschrift
Landbouwtijdschrift *(Belgium)*

Lasers Opt. Non Conv.
Lasers et Optique Non Conventionelle *(France)*

Lav. Med.
Lavoro e Medicina *(Italy)*

Lebensversicherungsmedizin
Lebensversicherungsmedizin *(West Germany)*

Light Metal Age
Light Metal Age *(U. S.)*

Light Metals
Light Metals (superseded by Light Metals and Metals Industry (London)) *(England)*

Light Metals Metal Ind. (London)
*Light Metals and Metal Industry (London) (formed by merger of Light Metals and The Metal Industry (London)) *(England)*

Lipids
Lipids *(U. S.)*

Liteinoe Proizvod.
Liteinoe Proizvodstvo *(U.S.S.R.)*

Lithos
Lithos *(Norway)*

Lutte Cancer
Lutte Contre le Cancer *(France)*

Machinery (N. Y.)
Machinery (New York) *(U. S.)*

Mach. Prod. Eng.
Machinery and Production Engineering *(England)*

Mach. Shop Eng. Mfg.
Machine Shop and Engineering Manufacture *(England)*

Mach. Tool Blue Book
Machine and Tool Blue Book *(U. S.)*

Mag. Stand.
Magazine of Standards *(U. S.)*

Magy. Traumatol., Orthop. Helyreallito Sebesz.
Magyar Traumatologia, Orthopaedia es Helyreallito Sebeszet *(Hungary)*

Manage. Sci.
Management Science *(U.S.)*

Mar. Eng.
Marine Engineering
see Fune No Kogaku

Mashinovedenie
Mashinovedenie *(U.S.S.R.)*

Mass Prod.
Mass Production *(England)*

Mater. Res. Bull.
Materials Research Bulletin *(U. S.)*

Meas. Instrum. Rev.
Measurement and Instrument Review *(England)*

Mech. World Eng. Rec.
*Mechanical World and Engineering Record *(England)*

Med. Bull. U. S. Army, Eur.
Medical Bulletin of the U. S. Army, Europe *(U.S.)*

Meded. Kon. Vlaam. Acad. Wetensch. Belg., Kl. Wetensch.
Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van Belgie, Klasse der Wetenschappen *(Belgium)*

Med.-Markt/Acta Medicotech.
Medizinal-Markt/Acta Medicotechnica *(Germany)*

Med. Nucl.-Radiobiol. Lat., Suppl.
*Medicina Nucleare–Radiobiologica Latina, Suppl. *(Italy)*

Med. Prom. SSSR
Meditsinskaya Promyshlennost SSSR *(U.S.S.R)*

Med. Radiol. (USSR) (Engl. Transl.)
Medical Radiology (USSR) (English Translation of Meditsinskaya Radiologiya) *(U. S.)*

Mekh. Elek. Sots. Sel. Khoz.
Mekhanizatsiya i Elektrifikatsiya Sotsialisticheskogo Sel'skogo Khozyaistva *(U.S.S.R.)*

Mekh. Polim.
Mekhanika Polimerov *(Latvian S.S.R.)*

Mekh. Razrusheniya Metal., Akad. Nauk Ukr. SSR, Respub. Mezhvedom. Sb.
Mekhanizm Razrusheniya Metallov, Akademiya Nauk Ukrainskoi SSR, Respublikanskii Mezhvedomstvennyi Sbornik *(Ukrainian S.S.R.)*

Mem. Fac. Educ., Kumamoto Univ.
Memoirs of the Faculty of Education, Kumamoto University
see Kumamoto Daigaku Kyoikugakubu Kiyo

Mem. Fac. Fish., Kagoshima Univ.
Memoirs of the Faculty of Fisheries, Kagoshima University
see Kagoshima Daigaku Suisangakubu Kiyo

Mem. Fac. Sci., Kyoto Univ., Ser. Biol.
Memoirs of the Faculty of Science, Kyoto University, Series of Biology (formerly Memoirs of the College of Science, University of Kyoto, Series B (Biology)) *(Japan)*

Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem.
Memoirs of the Faculty of Science, Kyoto University, Series of Physics, Astrophysics, Geophysics, and Chemistry (formerly Memoirs of the College of Science, University of Kyoto, Series A) *(Japan)*

Mem. Hyogo Univ. Agr.
Memoirs of the Hyogo University of Agriculture
see Hyogo Noka Daigaku Kiyo

Meres Automat.
Meres es Automatika *(Hungary)*

Mes., Regul., Automat.
Mesures, Regulation, Automatisme *(France)*

Messtechnik
*Messtechnik. Zeitschrift fuer Instrumentenkunde (supersedes Zeitschrift fuer Instrumentenkunde) *(West Germany)*

Metabolism
*Metabolism: Clinical and Experimental *(U. S.)*

Metal Finish.
Metal Finishing *(U. S.)*

Metallwirtschaft
Metallwirtschaft–Wissenschaft–Technik *(Germany)*

Metals (London)
Metals (London) *(England)*

Metals Abstr.
*Metals Abstracts (successor to Review of Metal Literature and Metallurgical Abstracts) *(U. S.-England)*

Metal Sci. Heat Treat. (USSR) (Engl. Transl.)
Metal Science and Heat Treatment (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) *(U. S.)*

Metal Treat.
Metal Treating *(U. S.)*

Met. Elec. (Madrid)
Metalurgia y Electricidad (Madrid) *(Spain)*

Meteoritika
Meteoritika *(U.S.S.R.)*

Method. Phys. Anal.
Methodes Physiques d'Analyse *(France)*

Meth. Phys. Anal.
Methodes Physiques d'Analyse *(France)*

Met. Rev. (Publ. in Metals Mater.)
Metallurgical Reviews (Published in Metals and Materials) *(England)*

Met. Spec. (Paris)
Metallurgie Speciale (Paris) *(France)*

Microwaves
Microwaves *(U. S.)*

Mie Kaibo Gyosekishu
Mie Kaibo Gyosekishu *(Japan)*

Milk Dealer
Milk Dealer, The *(U. S.)*

Miner. Deposita
Mineralium Deposita *(West Germany)*

Minerva Med. Giuliana
*Minerva Medica Giuliana. Supplemento a Minerva Medica *(Italy)*

Minerva Med. Sicil.
*Minerva Medica Siciliana (continuation of Gazzetta Medica Siciliana) Supplemento a Minerva Medica *(Italy)*

Minerva Med., Suppl.
*Minerva Medica, Supplemento *(Italy)*

Minerva Radiol.
*Minerva Radiologica (formerly Minerva Radiologica, Fisioterapica e Radiobiologica) *(Italy)*

Mines Met.
Mines et Metallurgie *(France)*

Mining Congr. J.
Mining Congress Journal *(U. S.)*

Mining Met. Quart. (USSR) (Engl. Transl.)
Mining and Metallurgy Quarterly (USSR) (English Translation of Rudarsko-Metalurski Zbornik) *(Yugoslavia)*

Mining Met. Quart. (USSR) (Engl. Transl.), Suppl.
Mining and Metallurgy Quarterly, (USSR) (English Translation of Rudarsko-Metalurski Zbornik, Supplement) *(Yugoslavia)*

Mod. Packag.
Modern Packaging *(U. S.)*

Mod. Unfallverhuet.
Moderne Unfallverhuetung *(West Germany)*

Mokuzai Gakkaishi
Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) *(Japan)*

Mol. Biol.
*Molekulyarnaya Biologiya *(U.S.S.R.)*

Mon. Corresp. Befoerd. Erd Himmelskunde
Monatliche Correspondenz zur Befoerderung der Erd und Himmelskunde *(East Germany)*

Monit. Zool. Ital., Suppl.
Monitore Zoologico Italiano, Supplemento *(Italy)*

Monogr. Nucl. Med. Biol.
Monographs on Nuclear Medicine and Biology *(Netherlands)*

Montes
Montes *(Spain)*

Motor Ship
Motor Ship *(England)*

Motortech. Z.
Motortechnische Zeitschrift *(West Germany)*

Muanyag Gumi
Muanyag es Gumi *(Hungary)*

Nachrichtentech. Fachber.
Nachrichtentechnische Fachberichte *(West Germany)*

Nachrichtentechnik
Nachrichtentechnik *(East Germany)*

Nagano Kogyo Koto Senmon Gakko Kiyo
Nagano Kogyo Koto Senmon Gakko Kiyo (Research Reports, Nagano Technical College) *(Japan)*

Nagasaki Igakkai Zasshi, Suppl.
Nagasaki Igakkai Zasshi, Supplement (Journal of the Nagasaki Medical Association, Supplement) *(Japan)*

Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Universitatis Nankinensis Scientiarum Naturalium) *(China)*

Nat. Fire Codes
National Fire Codes *(U. S.)*

Nat. Med. J. China
National Medical Journal of China
see Chung Hua I Hsueh Tsa Chih

Nauch. Zap. Inst. Mashinoved. Avtomat., Akad. Nauk Ukr. SSR, Ser. Mashinoved.
Nauchnye Zapiski Instituta Mashinovedeniya i Avtomatiki, Akademiya Nauk Ukraninskoi SSR, Seriya Mashinovedeniya *(Ukrainian S.S.R.)*

Neftegazov. Geol. Geofiz.
Neftegazovaya Geologiya i Geofizika *(U.S.S.R.)*

Nerv. Sist., Leningrad. Gos. Univ., Fiziol. Inst.
Nervnaya Sistema, Leningradskii Gosudarstvennyi Universitet imeni A. A. Zhdanova, Fiziologicheskii Institut *(U.S.S.R.)*

Neth. J. Sea Res.
Netherlands Journal of Sea Research *(Netherlands)*

Neues Jahrb. Mineral., Monatsh.
Neues Jahrbuch fuer Mineralogie, Monatshefte *(West Germany)*

Newslett. Isotop. Generator Inform. Centre
*Newsletter of the Isotopic Generator Information Centre *(France)*

Nippon Byori Gakkai Kaishi
Nippon Byori Gakkai Kaishi (Transactiones Societatis Pathologicae Japonicae) *(Japan)*

Nippon Chikusangaku Kaiho
Nippon Chikusangaku Kaiho (Japanese Journal of Zootechnical Science) *(Japan)*

Nippon Geka Hokan
Nippon Geka Hokan (Archiv fuer Japanische Chirurgie) *(Japan)*

Nippon Gomu Kyokaishi
Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry, Japan) *(Japan)*

Nippon Ishikai Zasshi
Nippon Ishikai Zasshi (The Journal of the Japan Medical Association) *(Japan)*

Nippon Kaisui Gakkaishi
Nippon Kaisui Gakkaishi (Bulletin of the Society of Sea Water Science, Japan) *(Japan)*

Nippon No Kagaku To Gijutsu
Nippon No Kagaku To Gijutsu (Science and Technology of Japan) *(Japan)*

Nippon Sakumotsu Gakkai Kiji
Nippon Sakumotsu Gakkai Kiji (Proceedings of the Crop Science Society of Japan) *(Japan)*

Nippon Shokuhin Kogyo Gakkaishi
Nippon Shokuhin Kogyo Gakkaishi (Journal of Food Science and Technology) *(Japan)*

Nisshin Seiko Giho
Nisshin Seiko Giho (Technical Report of Nisshin Steel Co., Ltd.) *(Japan)*

Nord. Med.
Nordisk Medicin *(Sweden)*

Norsk Skogind.
Norsk Skogindustri *(Norway)*

Nucl. India
Nuclear India *(India)*

Nucl. Law Bull.
*Nuclear Law Bulletin *(Belgium)*

Nucl. Law Bull., Suppl.
*Nuclear Law Bulletin, Supplement *(Belgium)*

Nukleonika, Supl.
*Nukleonika, Suplement *(Poland)*

N. Z. Dent. J.
New Zealand Dental Journal *(New Zealand)*

N. Z. J. Agr.
New Zealand Journal of Agriculture *(New Zealand)*

N. Z. Med. J., Suppl.
New Zealand Medical Journal, Supplement *(New Zealand)*

N. Z. Sci. Rev.
New Zealand Science Review *(New Zealand)*

Oceanogr. Mag.
Oceanographical Magazine, The *(Japan)*

Ochr. Pr.
Ochrona Pracy *(Poland)*

Odontol. Tidskr.
Odontologisk Tidskrift *(Sweden)*

Oftal'mol. Zh.
Oftal'mologicheskii Zhurnal *(Ukrainian S.S.R.)*

Ohio State Med. J.
Ohio State Medical Journal *(U. S.)*

Okayama Daigaku Onsen Kenkyusho Hokoku
Okayama Daigaku Onsen Kenkyusho Hokoku (Papers of the Inst. for Thermal Spring Research, Okayama University) *(Japan)*

Oncol. Radiol.
Oncologia si Radiologia *(Romania)*

Onde Elec., Suppl.
*Onde Electrique, L., Supplement *(France)*

Onsen Kagaku
Onsen Kagaku (Journal of the Balneological Society of Japan) *(Japan)*

Onsen Kogakkaishi
Onsen Kogakkaishi (Journal of the Society of Engineers for Mineral Springs, Japan) *(Japan)*

Opt.-Mekh. Prom.
Optiko-Mekhanicheskaya Promyshlennost *(U.S.S.R.)*

Osaka Daigaku Shigaku Zasshi
Osaka Daigaku Shigaku Zasshi (The Journal of Osaka University Dental Society) *(Japan)*

Osaka Furitsu Kogyo Shoreikan Hokoku
Osaka Furitsu Kogyo Shoreikan Hokoku (Reports of Industrial Research Inst., Osaka Prefecture) *(Japan)*

Osaka Kogyo Gijutsu Shikensho Kiho
Osaka Kogyo Gijutsu Shikensho Kiho (Bulletin of the Government Industrial Research Institute, Osaka) *(Japan)*

Oto-Rhino-Laryngol. Clin.
Oto-Rhino-Laryngological Clinic
see Jibiinkoka Rinsho

Paleogeogr., Paleoclimatol., Paleoecol.
Paleogeography, Paleoclimatology, Paleoecology *(Netherlands)*

Paperi Puu-Lehdesta
Paperi ja Puu-Lehdesta *(Finland)*

Pap. Inst. Thermal Spring Res., Okayama Univ.
Papers of the Inst. for Thermal Spring Research, Okayama University
see Okayama Daigaku Onsen Kenkyusho Hokoku

Pediatrics, Suppl.
Pediatrics, Supplement *(U. S.)*

Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium Universitatis Pekinensis) *(China)*

Petrol Gaze
*Petrol si Gaze *(Romania)*

Photogr. Appl. Sci. Technol.
*Photographic Applications in Science and Technology *(U. S.)*

Phys. Bull. (London)
Physics Bulletin (London) *(England)*

Phys.-Diaet. Ther.
Physikalisch-Diaetetische Therapie *(West Germany)*

Phys. Earth Planet. Interiors
*Physics of the Earth and Planetary Interiors *(Netherlands)*

Pipes Pipelines Int.
Pipes and Pipelines International (formerly International Pipes and Pipelines) *(England)*

Piping Eng.
Piping Engineering, The
see *Haikan Gijutsu*

Plant Breed. Abstr.
*Plant Breeding Abstracts *(England)*

Plant Cell Physiol. (Kyoto)
Plant and Cell Physiology (Kyoto) *(Japan)*

Plant Physiol., Suppl.
*Plant Physiology, Supplement *(U. S.)*

Plastics (London)
*Plastics (London) *(England)*

Poluprov. Prib. Ikh Primen., Sb. Statei
Poluprovodnikovye Pribory i Ikh Primenenie, Sbornik Statei *(U.S.S.R.)*

Pop. Sci. (Peking)
Popular Science (Peking)
see *K'o Hsueh Ta Chung*

Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Farm.
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Farmaceutycznej *(Poland)*

Praxis (Bern)
Praxis (Bern) *(Switzerland)*

Probl. Fiziol. Opt.
Problemy Fiziologicheskoi Optiki *(U.S.S.R.)*

Proc. Amer. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science *(U. S.)*

Proc. Astron. Soc. Aust.
Proceedings of the Astronomical Society of Australia *(Australia)*

Proc. Crop Sci. Soc. Jap.
Proceedings of the Crop Science Society of Japan
see *Nippon Sakumotsu Gakkai Kiji*

Proc. Egypt. Acad. Sci.
Proceedings of the Egyptian Academy of Sciences *(Egypt)*

Prochnost Din. Aviats. Dvigatelei
Prochnost i Dinamika Aviatsionnykh Dvigatelei *(U.S.S.R.)*

Proc. Indian Acad. Sci., Sect. B
Proceedings of the Indian Academy of Sciences, Section B *(India)*

Proc. La. Acad. Sci.
*Proceedings of the Louisiana Academy of Sciences, The *(U. S.)*

Proc. Nat. Acad. Sci., India, Sect. A
Proceedings of the National Academy of Sciences, India, Section A *(India)*

Proc. Phys. Soc. (London)
Proceedings of the Physical Society (London) changed to Journal of Physics, A, B, and C *(England)*

Proc. Soc. Water Treat. Exam.
Proceedings of the Society for Water Treatment and Examination *(England)*

Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.)
*Proceedings (Trudy) of the P. N. Lebedev Physics Institute (USSR) (English Translation of Trudy Fizicheskogo Instituta imeni P. N. Lebedeva, Akademiya Nauk SSSR) *(U. S.)*

Prod. Eng.
Product Engineering *(U. S.)*

Prod. Pharm.
Produits Pharmaceutiques *(France)*

Progr. Anal. Chem.
Progress in Analytical Chemistry *(U. S.)*

Progr. High Temp. Phys. Chem.
Progress in High Temperature Physics and Chemistry *(England)*

Progr. Ind. Microbiol.
Progress in Industrial Microbiology *(U. S.–England)*

Progr. Nucl. Tech. Instrum.
Progress in Nuclear Techniques and Instrumentation *(Netherlands)*

Progr. Solid State Chem.
Progress in Solid State Chemistry *(England)*

Progr. Stiintei
Progresele Stiintei *(Romania)*

Prot. Civ. Secur. Ind.
Protection Civile et Securite Industrielle *(France)*

Protein, Nucl. Acid, Enzyme
Protein, Nucleic Acid, Enzyme
see *Tanpakushitsu Kakusan Koso*

Przegl. Lek.
Przeglad Lekarski *(Poland)*

PTB Mitt.
*PTB Mitteilungen. Amts- und Mitteilungsblatt der Physikalisch-Technischen Bundesanstalt *(West Germany)*

Pubb. Centro Sper. Agr. Forest.
Pubblicazioni del Centro di Sperimentazione Agricola e Forestale *(Italy)*

Queensland Govt. Mining J.
Queensland Government Mining Journal *(Australia)*

Radiat. Res. Rev.
Radiation Research Reviews *(Netherlands)*

Radio (China)
Radio (China)
see *Wu Hsien Tien*

Radiobiol. Biol. Mol.
Radiobiologia si Biologia Moleculara *(Romania)*

Radioprotection
Radioprotection. Bulletin de la Societe Francaise de Radioprotection *(France)*

Rad. Poljopr. Fak. Univ. Sarajevu
Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu *(Yugoslavia)*

Rakuno Kagaku No Kenkyu
Rakuno Kagaku No Kenkyu (Japanese Journal of Dairy Science) *(Japan)*

Rast. Nauki
Rasteniev'dni Nauki *(Bulgaria)*

Razved. Okhr. Nedr
Razvedka i Okhrana Nedr *(U.S.S.R.)*

RCN (Reactor Cent. Ned.) Mededel.
RCN (Reactor Centrum Nederland) Mededeling *(Netherlands)*

Reactor Fuel-Process. Technol.
*Reactor and Fuel-Processing Technology (A Quarterly Technical Progress Review) (formerly Power Reactor Technology and Reactor Fuel Processing) *(U. S.)*

Rec. Trav. Bot. Neer.
Recueil des Travaux Botaniques Neerlandais *(Netherlands)*

Rend. Semin. Mat. Fis. Milano
Rendiconti del Seminario Matematico e Fisico di Milano *(Italy)*

Rep. Fac. Sci., Shizuoka Univ.
Reports of Faculty of Science, Shizuoka University *(Japan)*

Rep. Fire Res. Inst. Jap.
Report of Fire Research Inst. of Japan
see *Shobo Kenkyusho Hokoku*

Rep. Hokkaido Inst. Public Health
Report of the Hokkaido Inst. of Public Health
see *Hokkaidoritsu Eisei Kenkyushoho*

Rep. Ind. Res. Inst., Osaka Prefect.
Reports of Industrial Research Inst., Osaka Prefecture
see *Osaka Furitsu Kogyo Shoreikan Hokoku*

Rep. Nat. Res. Inst. Police Sci.
Reports of the National Research Inst. of Police Science
see *Kagaku Keisatsu Kenkyusho Hokoku*

Rep. Res. Inst. Ind. Safety
Reports of the Research Inst. of Industrial Safety
see *Sangyo Anzen Kenkyusho Hokoku*

Rep. Res. Inst. Sci. Ind., Kyushu Univ.
Reports of the Research Inst. of Science and Industry, Kyushu University
see *Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku*

Rep. Tokyo-to Lab. Med. Sci.
Report of Tokyo-to Lab. for Medical Sciences
see *Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku*

Rep. Train. Inst. Eng. Teach., Kyoto Univ.
Report of the Training Inst. for Engineering Teachers, Kyoto University
see *Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku*

Res. Electrotech. Lab.
Researches of the Electrotechnical Laboratory
see *Denki Shikenjo Kenkyu Hokoku*

Res. Rep., Nagano Tech. Coll.
Research Reports, Nagano Technical College
see *Nagano Kogyo Koto Senmon Gakko Kiyo*

Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza
Revista de la Academia de Ciencias Exactas, Fisico-Quimicas y Naturales de Zaragoza *(Spain)*

Rev. Brasil. Quim. (Sao Paulo)
*Revista Brasileria de Quimica *(Brazil)*
Rev. Elec.
Revista Electricidade *(Portugal)*
Rev. Energ. Primaire
Revue Energie Primaire *(Belgium)*
Rev. Fac. Cienc. Agr., Min. Educ., Univ. Nac. Cuyo (Mendoza)
Revista de la Facultad de Ciencias Agrarias, Ministerio de Educacion, Universidad Nacional de Cuyo (Mendoza) *(Argentina)*
Rev. Fr. Elec.
*Revue Francaise de l' Electricite *(France)*
Rev. Fr. Odonto-stomatol.
Revue Francaise d'Odonto-stomatologie *(France)*
Rev. Gen. Caout. Plast.
Revue Generale du Caoutchouc et des Plastiques *(France)*
Rev. Interamer. Radiol.
Revista Interamericana de Radiologia *(Peru)*
Rev. Int. Oceanogr. Med.
*Revue Internationale d'Oceanographie Medicale *(France)*
Rev. Laryngol., Otol., Rhinol., Suppl.
Revue de Laryngologie, Otologie, Rhinologie, Supplement *(France)*
Rev. Real Acad. Cienc. Exact., Fis. Nat. Madrid
Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid *(Spain)*
Rev. Roum. Sci. Tech., Ser. Mecan. Appl.
Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee *(Romania)*
Rev. Soudure (Brussels)
Revue de la Soudure (Brussels) *(Belgium)*
Rev. Stomatol.
Revue de Stomatologie *(France)*
Rev. Zootch. Med. Vet.
Revista de Zootehnic si Medicina Veterinara *(Romania)*
Rheol. Acta
Rheologica Acta *(West Germany)*
Riv. Mineraria Sicil.
Rivista Mineraria Siciliana *(Italy)*
Roczn. Akad. Med. Bialymstoku
Roczniki Akademii Medycznej im. Juliana Marchlewskiego w Bialymstoku *(Poland)*
Roy. Observ. Bull.
Royal Observatory Bulletins *(England)*
Roy. Soc. Health J.
Royal Society of Health Journal *(England)*
Rudarsko-Met. Zbornik, Suppl.
Rudarsko-Metalurski Zbornik, Supplement *(Yugoslovia)*
For English Translation see Mining Met. Quart., Suppl.
Rudodobiv Met. (Sofia)
Rudodobiv i Metalurgiya (Sofia) *(Bulgaria)*
Ruimtevaart
Ruimtevaart *(Netherlands)*
RUM, Rev. Universelle Mines
RUM, Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l' Industrie (formerly Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie) *(Belgium)*
Russ. Chem. Rev. (Engl. Transl.)
Russian Chemical Reviews (English Translation of Uspekhi Khimii) *(England)*
S. Afr. Mech. Eng.
South African Mechanical Engineer, The *(South Africa)*
Salt Res. Ind. (Bhavnagar, India)
Salt Research and Industry (Bhavnagar, India) *(India)*
Samoletostr. Tekh. Vozdush. Flota
Samoletostroenie i Tekhnika Vozdushnogo Flota *(U.S.S.R.)*
Sangyo Anzen Kenkyusho Hokoku
Sangyo Anzen Kenkyusho Hokoku (Reports of the Research Inst. of Industrial Safety) *(Japan)*
Sb. Geol. Ved, Uzita Geofyz.
Sbornik Geologickych Ved, Uzita Geofyzika *(Czechoslovakia)*
Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, Suppl.
Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove, Supplementum *(Czechoslovakia)*
Scand. J. Clin. Lab. Invest., Suppl.
Scandinavian Journal of Clinical and Laboratory Investigation, Supplement *(Sweden)*
Schweiz. Arch. Tierheilk.
Schweizer Archiv fuer Tierheilkunde *(Switzerland)*
Schweiz. Muenzbl.
Schweizer Muenzblaetter *(Switzerland)*
Sci. Avenir
Sciences et Avenir *(France)*
Sciences (Paris)
Sciences et l'Enseignement des Sciences (Paris) *(France)*
Sci. Forum
Science Forum *(Canada)*
Sci. Ind. Spatiales
Sciences et Industries Spatiales *(Switzerland)*
Sci. News (Wash., D. C.)
Science News (Washington, D. C.) *(U. S.)*
Sci. Proc. Roy. Dublin Soc., Ser. A
Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*
Sci. Rep., Coll. Gen. Educ., Osaka Univ.
Science Report, College of General Education, Osaka University *(Japan)*
Sci. Rep. Niigata Univ., Ser. B
Science Reports of Niigata University, Series B. Physics *(Japan)*
Scot. J. Polit. Econ.
Scottish Journal of Political Economy *(Scotland)*
Scr. Met.
Scripta Metallurgica *(U. S.)*
Sekiyu Gakkaishi
Sekiyu Gakkaishi (Journal of the Japan Petroleum Institute) *(Japan)*
Seminars Hematol.
*Seminars in Hematology *(U. S.)*
Seminars Roentgenol.
Seminars in Roentgenology *(U. S.)*
Sen'i Gakkaishi
Sen'i Gakkaishi (Journal of the Society of Fiber Science and Technology, Japan) *(Japan)*
Ser. Haematol.
Series Haematologica (Supplements Scandinavia Journal of Haematology) *(Denmark)*
Sheet Metal Ind.
Sheet Metal Industries *(England)*
Shipping World Shipbuilder
Shipping World and Shipbuilder *(England)*
Shobo Kenkyusho Hokoku
Shobo Kenkyusho Hokoku (Report of Fire Research Inst. of Japan) *(Japan)*
Showa Densen Denran Rebyu
Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*
Showa Wire Cable Rev.
Showa Wire and Cable Review
see Showa Densen Denran Rebyu
Sichere Arb.
Sichere Arbeit *(Austria)*
Slaboproudy Obz.
Slaboproudy Obzor *(Czechoslovakia)*
S. Lumberman
Southern Lumberman *(U. S.)*
Soc. Petrol. Eng. J.
Society of Petroleum Engineers Journal, The *(U. S.)*
Soil Crop Sci. Soc. Fla., Proc.
Soil and Crop Science Society of Florida, Proceedings *(U. S.)*
Solid State Technol.
Solid State Technology *(U. S.)*
Soln. Dannye
Solnechnyie Dannye *(U.S.S.R.)*
Soobshch. Shemakhinskoi Astrofiz. Observ., Akad. Nauk Azerb. SSR
*Soobshcheniya Shemakhinskoi Astrofizicheskoi Observatorii, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*
Southwest. Natur.
Southwestern Naturalist *(U. S.)*
Sov. Antarct. Exped. Inform. Bull.
Soviet Antarctic Expedition Information Bulletin (English Translation of Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii) *(U. S.)*
Sov. Phys.-Semicond. (Engl. Transl.)
Soviet Physics-Semiconductors (English Translation of Fizika i Tekhnika Poluprovodnikov) *(U. S.)*
Space Biol. Med. (USSR) (Engl. Transl.)
Space Biology and Medicine (USSR) (English Translation of Kosmicheskaya Biologiya i Meditsina) *(U.S.)*
Space Life Sci.
Space Life Sciences *(Netherlands)*
Spectrum (Oxford)
Spectrum (Oxford) *(England)*
Spis. Bulg. Akad. Nauk.
Spisanie na Bulgarskata Akademiya na Naukite *(Bulgaria)*
SRW (Siemens-Reiniger-Werke) Nachr.
SRW (Siemens-Reiniger-Werke) Nachricht *(West Germany)*

Ssu Ch'uan Ta Hsueh Hsueh Pao—Tzu Jan K'o Hsueh
Ssu Ch'uan Ta Hsueh Hsueh Pao—Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium, Universitatis Szechuanensis) *(China)*

Stainless (Tokyo)
Stainless, The (Tokyo)
see ***Sutenresu***

Stain Technol.
Stain Technology *(U. S.)*

Steel Times
Steel Times *(England)*

Strahlenschutz Forsch. Prax.
Strahlenschutz in Forschung und Praxis *(West Germany)*

Strain
Strain *(England)*

Stroit. Mater.
Stroitel'nye Materialy *(U.S.S.R.)*

Stud. Cercet. Endocrinol.
Studii si Cercetari de Endocrinologie *(Romania)*

Stud. Cercet. Energ. Electroteh.
Studii si Cercetari de Energetica si Electrotehnica *(Romania)*

Stud. Cosmic Ray
Studies of Cosmic Ray
see ***Uchusen Kenkyu***

Sumitomo Kinzoku
Sumitomo Kinzoku (Sumitomo Metals) *(Japan)*

Sumitomo Metals
Sumitomo Metals
see ***Sumitomo Kinzoku***

Sutenresu
Sutenresu (The Stainless) *(Japan)*

Svetsaren Engl.
Svetsaren in English *(Sweden)*

Sv. Lakartidn.
Svenska Lakartidningen *(Sweden)*

Sv. Naturvetensk.
Svensk Naturvetenskap *(Sweden)*

T'ai-wan I Hsueh Hui Tsa Chih
T'ai-wan I Hsueh Hui Tsa Chih (Journal of the Formosan Medical Association) *(China (Taiwan))*

Tanpakushitsu Kakusan Koso
Tanpakushitsu Kakusan Koso (Protein, Nucleic Acid, Enzyme) *(Japan)*

Tech. Dig. (Prague)
Technical Digest (Prague), Statni Nakladatelstvi Technicke Literatury *(Czechoslovakia)*

Tech. Mitt. AEG-Telefunken
*Technische Mitteilungen AEG-Telefunken (a continuation of AEG-Mitteilungen) *(West Germany)*

Technik (Berlin)
Technik (Berlin), Die *(East Germany)*

Technology (Sindri)
Technology (Sindri). Quarterly Bulletin of the Planning and Development Div., Fertilizer Corp. of India Ltd. *(India)*

Technol. Rep. Kyushu Univ.
Technology Reports of the Kyushu University
see ***Kyushu Daigaku Kogaku Shuho***

Tech. Note Port Harbour Tech. Res. Inst., Min. Transp., Jap.
Technical Note of Port and Harbour Technical Research Inst., Ministry of Transporation, Japan
see ***Kowan Gikon Shiryo***

Tech. Petrole
Techniques du Petrole *(France)*

Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A
Technical Report of ISSP (Inst. for Solid State Physics), Series A *(Japan)*

Tech. Rep. Kumamoto Univ.
Technical Reports of the Kumamoto University
see ***Kumamoto Daigaku Kogakubu Kenkyu Hokoku***

Tech. Rep. Nisshin Steel Co., Ltd.
Technical Report of Nisshin Steel Co., Ltd.
see ***Nisshin Seiko Giho***

Tech. Sci. Aeronaut. Spatiales
Technique et Science Aeronautiques et Spatiales *(France)*

Tec. Ital.
Tecnica Italiana *(Italy)*

Tekhnol. Organ. Proizvod.
Tekhnologiya i Organizatsiya Proizvodstva *(Ukrainian S.S.R.)*

Tekst. Prom.
Tekstil'naya Promyshlennost *(U.S.S.R.)*

Teor. Prakt. Met., Sov. Nar. Khoz. Chelyabinsk. Ekon. Admin. Raiona, Nauch.-Issled. Inst. Met.
Teoriya i Praktika Metallurgii, Sovet Narodnogo Khozyaistva Chelyabinskogo Ekonomicheskogo Administrativnogo Raiona, Nauchno-Issledovatel'skii Institut Metallurgii *(U.S.S.R.)*

Terapia (Milan)
Terapia (Milan) *(Italy)*

Terapia (Turin)
Terapia (Turin) *(Italy)*

Therapiewoche
Therapiewoche *(West Germany)*

Thin Solid Films
Thin Solid Films *(Netherlands)*

Thoraxchir. Vask. Chir.
Thoraxchirurgie und Vaskulaere Chirurgie (formerly Thoraxchirurgie) *(West Germany)*

Tien Shih Chieh
Tien Shih Chieh (Electrical World) *(China)*

Tijdschr. Primaire Energ.
Tijdschrift Primaire Energie
see ***Rev. Energ. Primaire***

Tohoku Daigaku Senko Seiren Kenkyusho Iho
Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University) *(Japan)*

Tokyo Astron. Bull., Ser. II
Tokyo Astronomical Bulletin, Series II *(Japan)*

Tokyo Daigaku Jishin Kenkyusho Iho
Tokyo Daigaku Jishin Kenkyusho Iho (Bulletin of the Earthquake Research Inst., University of Tokyo) *(Japan)*

Tokyo Daigaku Uchu Koku Kenkyusho Hokoku
Tokyo Daigaku Uchu Kenkyusho Hokoku (Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo) *(Japan)*

Tokyo Joshi Ika Daigaku Zasshi
Tokyo Joshi Ika Daigaku Zasshi (Journal of Tokyo Women's Medical College) *(Japan)*

Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku
Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku (Report of Tokyo-to Lab. for Medical Sciences) *(Japan)*

Tonind.-Ztg. Keram. Rundsch.
Tonindustrie-Zeitung und Keramische Rundschau *(West Germany)*

Trans. Amer. Ophthalmol. Soc.
Transactions of the American Ophthalmological Society *(Canada)*

Trans. Indian Ceram. Soc.
Tranactions of the Indian Ceramic Society *(India)*

Trans. Ing.
*Transactions. Ingenioeren *(Denmark)*

Trans. Inst. Metal Finish.
Transactions of the Institute of Metal Finishing *(England)*

Transp. Stroit.
Transportnoe Stroitel'stvo *(U.S.S.R.)*

Trans. Soc. Instrum. Contr. Eng.
Transactions of the Society of Instrument and Control Engineers *(Japan)*

Trans. Soc. Pathol. Jap.
Transactiones Societatis Pathologicae Japonicae
see ***Nippon Byori Gakkai Kaishi***

Tr. Arkt. Antarkt. Nauch.-Issled.
Trudy Arkticheskogo i Antarkticheskogo Nauchno-Issledovatel'skogo Instituta *(U.S.S.R.)*

Travaux
Travaux *(France)*

Tr. Gos. Gidrol. Inst.
Trudy Gosudarstvennogo Gidrologicheskogo Instituta *(U.S.S.R.)*

Tr. Gos. Issled. Elektrokeram. Inst.
Trudy Gosudarstvennogo Issledovatel'skogo Elektrokeramicheskogo Instituta *(U.S.S.R.)*

Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal.
Trudy, Gosudarstvennyi Nauchno-Issledovatel'skii i Proektnyi Institut Splavov i Obrabotki Tsvetnykh Metaliov *(U.S.S.R.)*

Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Khimii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Met. Obogashch., Akad. Nauk Kaz. SSR
Trudy Instituta Metallurgii i Obogashcheniya, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Kaz. Nauch.-Issled. Inst. Onkol. Radiol.
Trudy Kazakhskogo Nauchno-Issledovatel'skogo Instituta Onkologii i Radiologii *(Kazakh S.S.R.)*

Tr. Kom. Spektrosk., Akad. Nauk SSSR
Trudy Komissii po Spektroskopii, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Lab. Ionoobmen. Protsessov Sorbtsii, Nauch.-Issled. Fiz.-Khim. Inst., Voronezh. Gos. Univ.

Trudy Laboratorii Ionoobmennykh Protsessov i Sorbtsii, Nauchno-Issledovatel'skii Fiziko-Khimicheskii Institut, Voronezhskii Gosudarstvennyi Universitet *(U.S.S.R.)*

Tr. Leningrad. Tekhnol. Inst. Tsellyul.-Bum. Prom.
Trudy Leningradskogo Tekhnologicheskogo Instituta Tsellyulozno-Bumazhnoi Promyshlennosti *(U.S.S.R.)*

Tr., Mosk. Aviats. Tekhnol. Inst.
Trudy, Moskovskii Aviatsionnyi Tekhnologicheskii Institut *(U.S.S.R.)*

Tr. Mosk. Vet. Akad.
Trudy Moskovskoi Veterinarnoi Akademii *(U.S.S.R.)*

Tr. Prikl. Bot. Genet. Selek.
Trudy po Prikladnoi Botanike, Genetike i Selektsii *(U.S.S.R.)*

Tr. Sib. Tekhnol. Inst.
Trudy Sibirskogo Tekhnologicheskogo Instituta *(U.S.S.R.)*

Tr. Sov. Antarkt. Eksped.
Trudy Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*

Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr.
Trudy Soyuznogo Nauchno-Issledovatel'skogo Instituta Priborostroeniya *(U.S.S.R.)*

Tr. Teor. Polya
Trudy po Teorii Polya *(U.S.S.R.)*

TRW Space Log
TRW Space Log *(U. S.)*

Tumor Res.
Tumor Research *(Japan)*

Tungsten News
Tungsten News *(U.S.)*

T Z Prakt. Metallbearb.
T Z fuer Praktische Metallbearbeitung *(West Germany)*

Uchuson Kenkyu
Uchusen Kenkyu (Studies of Cosmic Ray) *(Japan)*

Umsch. Wiss. Tech.
*Umschau in Wissenschaft und Technik *(West Germany)*

Univ. Mich. Med. Cent. J.
University of Michigan Medical Center Journal *(U. S.)*

Upr. Yadern. Energ. Ustanovkami, Sb. Statei
*Upravlenie Yadernymi Energeticheskimi Ustanovkami, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*

U. S. Nav. Inst., Proc.
United States Naval Institute, Proceedings *(U. S.)*

Vector (Baltimore)
Vector (Baltimore) *(U. S.)*

Ved. Pr. Vyzk. Ustavu Vet. Lek. Brne
Vedecke Prace Vyzkumneho Ustavu Veterinarniho Lekarstvi v Brne (superseded by Documenta Veterinaria) *(Czechoslovakia)*

Verpakking
Verpakking *(Netherlands)*

Vestn. Cesk. Spolecnosti Zool.
Vestnik Ceskoslovenske Spolecnosti Zoologicke *(Czechoslovakia)*

Vestn. Leningrad. Univ., Ser. Biol.
Vestnik Leningradskogo Universiteta, Seriya Biologii *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. I, Mat., Mekh.
Vestnik Moskovskogo Universiteta, Seriya I, Matematika, Mekhanika *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. IV. Geol.
Vestnik Moskovskogo Universiteta, Seriya IV. Geologiya *(U.S.S.R.)*

Vestn. Sel'skokhoz. Nauki (Moscow)
Vestnik Sel'skokhozyaistvennoi Nauki (Moscow) *(U.S.S.R.)*

Vestn. Ustred. Ustavu Geol.
Vestnik Ustredniho Ustavu Geologickeho *(Czechoslovakia)*

Vet. Med. Nauki (Sofia)
Veterinarno Meditsinski Nauki (Sofia), Izvestiya na Akademiyata na Selskostopanskite Nauki *(Bulgaria)*

Vierteljahrsschr. Schweiz. Sanitaetsoffiz.
Vierteljahrsschrift fuer Schweizerische Sanitaetsoffiziere *(Switzerland)*

Vodosnabzh. Sanit. Tekh.
Vodosnabzhenie i Sanitarnaya Tekhnika *(U.S.S.R.)*

Vojnoekon. Pregl.
Vojnoekonomski Pregled *(Yugoslavia)*

Vojnosanit. Pregl.
Vojnosanitetski Pregled *(Yugoslavia)*

Volt, Elec. Trade Mon.
Volt, Electrical Trade Monthly *(Japan)*

Vop. Eksp. Klin. Radiol., Khar'kov. Inst. Med. Radiol.
Voprosy Eksperimental'noi i Klinicheskoi Radiologii, Khar'kovskii Institut Meditsinskoi Radiologii *(Ukrainian S.S.R.)*

Water Res.
Water Research (supersedes in part Air and Water Pollution) *(England)*

Water Waste Treat.
Water and Waste Treatment *(England)*

Wear
Wear *(Netherlands)*

Weld. Eng.
Welding Engineer *(U. S.)*

Weld. Res. Counc. Bull.
Welding Research Council Bulletin *(U. S.)*

Wiad. Hutn.
Wiadomosci Hutnicze *(Poland)*

Wien. Z. Inn. Med. Grenzgeb.
Wiener Zeitschrift fuer Innere Medizin und ihre Grenzgebiete *(Austria)*

Wis. Med. J.
Wisconsin Medical Journal *(U. S.)*

Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*

Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*

Wonjaryogwon. Yon'gu Nonmun Chip
Wonjaryogwon. Yon'gu Nonmun Chip *see J. Nucl. Sci. (Seoul)*

World Meteorol. Organ. Bull.
*World Meteorological Organization Bulletin *(Switzerland)*

World Mining
World Mining *(U. S.)*

Wszechswiat
Wszechswiat *(Poland)*

Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao
Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao (Wuhan University Journal, Natural Sciences) *(China)*

Wuhan Univ. J., Natur. Sci.
Wuhan University Journal, Natural Sciences *see Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao*

Wu Hsien Tien
Wu Hsien Tien (Radio) *(China)*

Yaderno-Geofiz. Issled., Geofiz. Sb.
Yaderno-Geofizicheskie Issledovaniya, Geoficicheskii Sbornik *(U.S.S.R.)*

Yadern. Priborostr., Nauch.-Tekh. Sb.
Yadernoe Priborostroenie, Nauchno-Tekhnicheskii Sbornik *(U.S.S.R.)*

Yakugaku Kenkyu
Yakugaku Kenkyu (Japanese Journal of Pharmacy and Chemistry) *(Japan)*

Yuan Tzu Neng
Yuan Tzu Neng (Atomic Energy) *(China)*

Zap. Leningrad. Gorn. Inst.
Zapiski Leningradskogo Gornogo Instituta *(U.S.S.R.)*

Zem. Beton
Zement und Beton *(Austria)*

Zemlya Vselennaya
Zemlya i Vselennaya *(U.S.S.R.)*

Zentralbl. Neurochir.
Zentralblatt fuer Neurochirurgie *(East Germany)*

Z. Ernaehrungswiss., Suppl.
Zeitschrift fuer Ernaehrungswissenschaft, Supplementa *(West Germany)*

Zesz. Nauk. Politech. Slaska, Energ.
Zeszyty Naukowe Politechnika Slaska, Energetyka *(Poland)*

Zh. Org. Khim.
*Zhurnal Organicheskoi Khimii *(U.S.S.R.)*

Z. Immunitaetsforsch., Allergie Klin. Immunol.
Zeitschrift fuer Immunitaetsforschung, Allergie und Klinische Immunologie *(West Germany)*

Z. Kinderheilk.
Zeitschrift fuer Kinderheilkunde *(West Germany)*

Z. Math. Phys.
Zeitschrift fuer Mathematik und Physik *(East Germany)*

Z. Mikrosk.-Anat. Forsch.
Zeitschrift fuer Mikroskopisch-Anatomische Forschung (Abt. 2 of Jahrbuch fuer Morphologie und Mikroskopische Anatomie) *(East Germany)*

Zolnierz Pol.
Zolnierz Polski *(Poland)*

Zoologica (Seoul)
Zoologica (Seoul) *(South Korea)*

Zool. Zh.

Zoologicheskii Zhurnal *(U.S.S.R.)*
Z. Parasitenk.
Zeitschrift fuer Parasitenkunde *(West Germany)*
Z. Phys. Chem. B
Zeitschrift fuer Physikalische Chemie. Abt. B *(Germany)*
Z. Psychol. Physiol. Sinnesorg.
Zeitschrift fuer Psychologie und Physiologie der Sinnesorgane *(East Germany)*
Z. Sinnesphysiol.
Zeitschrift fuer Sinnesphysiologie *(East Germany)*
Z. Tech. Ueberwach.
Zeitschrift Technische Ueberwachung *(Austria)*
Z. Urol. Nephrol.
Zeitschrift fuer Urologie und Nephrologie *(East Germany)*

☆U. S. GOVERNMENT PRINTING OFFICE: 1968— 345-446/7